

Chemicals From Oil

CHEMISTRY

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The Fall of German Science

► BRILLIANT, deadly, anti-climactic as one of its own rockets, Germany has taken just a century to pass through an amazing cycle. In 1845 Liebig and Wöhler were drawing the young scientists of the world to their laboratories to learn the chemistry of life. Today science has long deserted Germany. There remains only its degenerate caricature, a mad chemistry of death.

For more than half a century the rocket shot upward, dazzling the world. Scientists still leading their professions tell you proudly of their degrees from German universities. The legend of German superiority dies hard, as hard as do the victims of starvation.

The brilliant explosion which for a time illuminated the earth has fizzled out. The charred stick has fallen. Humanity must sweep up the debris of an experiment that failed. Using the science which Germany rejected, we must now synthesize a world not for super-men but for common humanity.

Science is a way of life. It will make possible, if we have the wit to use it constructively, a society where more people can live more comfortably than has ever been possible in the world before. The technological civilization can economize the space needed by an agricultural civilization, just as the agricultural pattern developed on a fraction the space needed by a hunting culture. There is reason to believe that Germany's technological civilization developed as a response to her crowding population.

Must downfall, therefore, be the end of all endeavor? Because one nation has used great gifts to evil ends, shall we say science is bad? Or shall we utilize the knowledge we have of how to promote health and comfort and good-fellowship, and the brains of the scientists who can give us more knowledge, to light a steady beacon showing the way to better times ahead?

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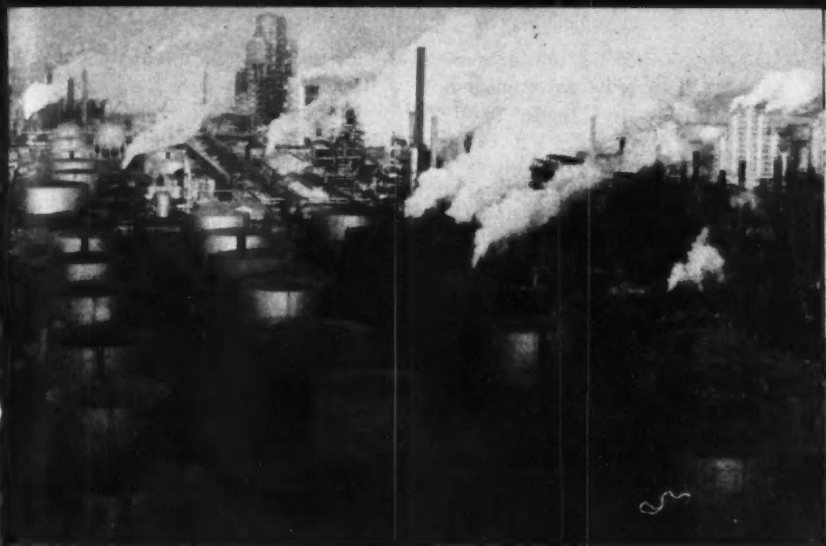
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► A CITY of tanks and towers processes oil—Baytown Refinery, Texas.

Oil---Mother of Chemicals

by MARTHA G. MORROW

► YOU WILL probably be able to get more mileage from your gas after the war; keep your home more nearly free of flies, mosquitoes and other pests; have a brighter, shinier car; and find your bread fresher in its waxed container because of advances recently made in the petroleum industry.

Better lipstick and face creams for the ladies, storm coats and fishing boots for the men, may also result from war-inspired developments in gasoline by-products, as well as more effective girdles for stout beauties, hotter "canned heat" for cooking hamburgers on picnics, and more efficient explosives for clearing farm lands and building roads.

Already the Allies are benefiting from 100-octane gasoline, which enables a plane to fly farther on a given quantity of fuel, or to carry a heavier load, or to travel faster. Oils have been developed which will flow about as freely when the plane is in the stratosphere where the surrounding temperature is 60 degrees below zero as when the plane is just taking off from the desert with its air sizzling around 110.

Special war weapons, such as the new oil incendiary bomb which has been causing so much damage in Japan's chief cities, the improved flame-thrower which is credited with shooting around corners, and the smoke generator which quickly hides ships

and factories from the air-borne enemy, all have the petroleum industry to thank for part of their new-found effectiveness.

The flamethrower which has been so successful in rooting Japs out of pillboxes spits out jets of flaming jellied gasoline. It can be aimed effectively whereas previous flamethrowers, using a petroleum liquid fuel, had to be fired down the wind and were risky to use.

The "gel gas," which sticks to whatever it strikes, is made by adding a gray powder to ordinary motor gasoline. This thickened oil increases the range of the weapon three-fold. Since the gel is just beginning to burn when it reaches the pillbox, fire instead of just flame is really being thrown at the enemy. The fuel leaves the nozzle of the flamethrower, which weighs no more than a soldier's full pack, as a glowing rod of fire and flows much like water when the hose nozzle is set for a sharp stream.

Gel gas is also used in incendiary bombs which can completely destroy factory buildings and the machines in them. Although the flame temperature of magnesium, used in the bombs which fell upon London early in the war, is higher than that of gasoline, it was found that gasoline has a heat content almost twice that of magnesium and is thus better for starting destructive fires.

The bombs, which look like a piece of hexagonal pipe, can be packed into clusters of as many as 60, the clusters breaking open as they fall. The bomb is equipped with a fuse which begins its deadly work only upon striking the ground. It ignites a three- to five-second powder train which allows enough

time for the bomb to come to rest on its side.

The powder train explodes a mixture of black powder and magnesium which hurls an ignited cheesecloth sock filled with the gel gas from the tail of the bomb; it strikes with such force that the sock is broken and flaming "goo" spread all around.

The bomb is kept right side up by a cloth tail streamer which flies out when the bomb falls free. This also makes it possible to aim with greater accuracy. The streamer also slows the fall so that the bomb does not strike so hard as to keep it from exploding properly.

Smoke so concealing that enough can be quickly generated from two quarts of the liquid mixture to hide the average city block is protecting our men and positions overseas. Generated from a petroleum derivative, the oil fog comes out like steam from a locomotive safety valve, and hangs over the area, hiding it completely. The smoke particles are so small that it would take tens of thousands of them, set side by side, to make a row one inch long.

The new smoke-making mixture, which has a petroleum base, is inexpensive to produce, plentiful to supply and entirely harmless to those whom it conceals. Men can breathe it, walk through it with their eyes wide open, and even smoke in it.

Although these new petroleum-users were developed solely to help win the war, they may find peacetime applications. Some believe that the smoke-generator may help protect crops by keeping orchards and fields from freezing when a cold wave suddenly begins to nip young buds or fruit. If you are

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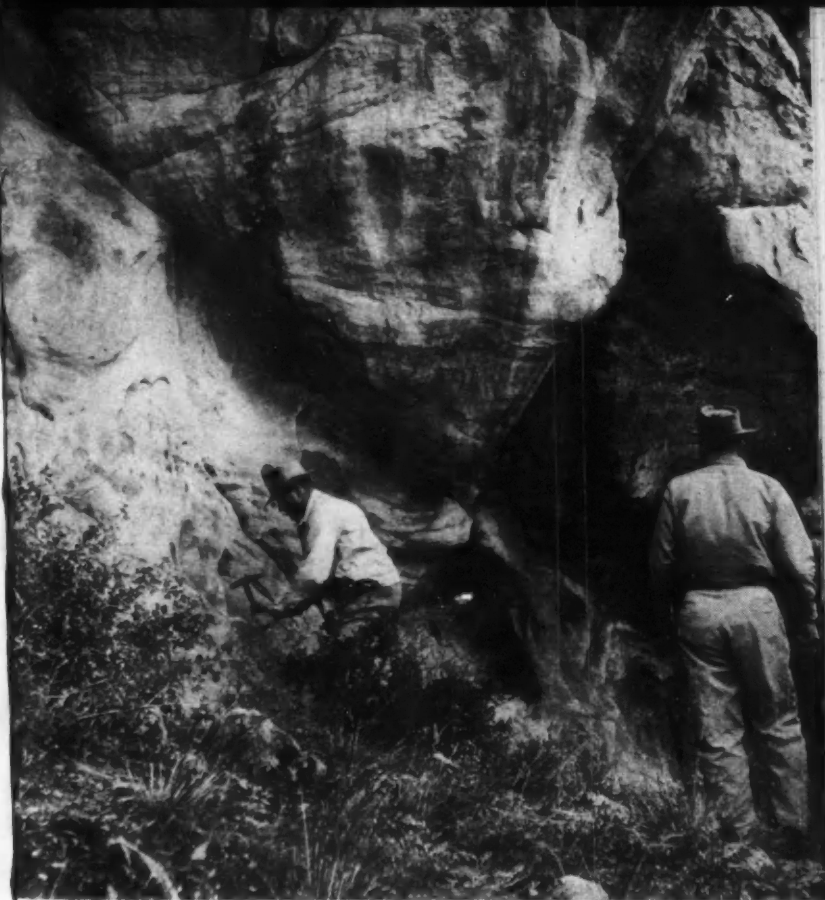
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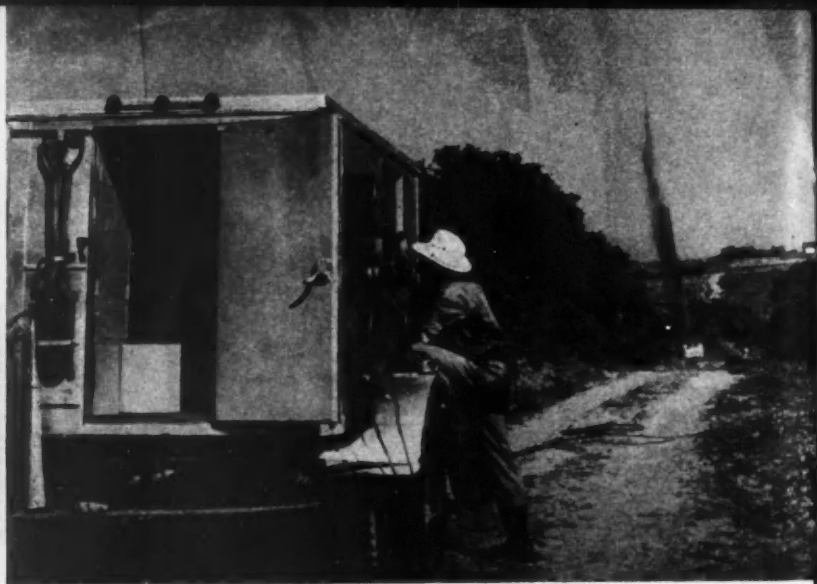
ISTRY



► THE GEOLOGIST samples rock outcrops—Tensleep Sand, near Warren, Montana.

"roughing it" for several days and run out of fuel for your stove, that postwar steak can still be done to a turn. Just make some "canned heat" similar to the gel gas by adding a little of the special powder to your motor gasoline.

Lower-cost care for a given performance and increased mileage are expected to result from 100-octane gasoline. As much as 35 to 40 miles to the gallon will be possible—say three or four years after the war—when engines are built to get the most out of



➤ A SMALL CHARGE of an explosive sets up a miniature earthquake which is recorded on a seismograph in the truck. The wavy lines of these records tell the kind of rock the tremor passed through, and allow the geologist to predict where oil will be found.



the new gas. With a slight modification of the engine-block head, existing cars could take reasonable advantage of gasoline approaching 100 octane, petroleum officials believe.

Owners of new cars after the war may not appreciate improvements which have been made in high quality oils, but those who buy used cars will find that the engine runs more smoothly and lasts longer. Oils which resist oxidation, and are not as likely to cause piston rings to stick or to let varnish deposits form, have been obtained by adding as little as 1 to 2 per cent of a metallic derivative of phenolic structure.

Lubricants have been developed from petroleum which more effectively keep moisture out of delicate engine parts, thus protecting against deterioration billions of dollars worth of material shipped to all parts of the world. Some types of greases, which look as black and sticky as asphalt, not only prevent rust but tend to displace slight bits of moisture.

About 95 per cent of the toluol, the second "T" in TNT, came during the last war as a coke byproduct. The first tank car of synthetic nitration-grade toluol was made in America just 16 months before the war broke upon us. Today most of the toluol used in our

➤ *HOLLOW CYLINDRICAL DRILLS cut samples out of the rock strata they pass through, and these rock cores are lined up for inspection. (The geologist is not eating the rock—taste and odor are useful tests.)*

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► *THE DERRICK is the sign and symbol of the oil field, whether the oil occurs under land or under Lake Maracaibo, Venezuela.*

shells, bombs and torpedoes is made synthetically from petroleum. Toluol will probably be greatly used as a solvent for paints and dyes in the plastic industry after the war.

Raincoats which drape nicely about the figure and storm suits which keep out the cold and wet will probably be made after the war of synthetic rubber. Large quantities of synthetic rubber are now being made from butadiene (from petroleum) and styrene (from coal tar) to keep our tanks and jeeps rubber-shod. When peace returns this research may lead to more attractive shower curtains, and washable, long-wearing rubber sheets for baby cribs.

The United States produces about 65% to 70% of the world's petroleum supply. A solution of gaseous and solid hydrocarbons in a mixture of liquid hydrocarbons, this "rock-oil" is found in geological formations, sometimes only a few feet below the ground, sometimes a mile or more.

The various substances found in petroleum have different boiling points so that the various components may be separated by fractional distillation, or heating. Products from petroleum range from gases, for illumination, heat and synthetic rubber; light oil, which is used for gasoline and kerosene; medium oil, from which metallurgical and diesel fuels are made; heavy oil, from which come insecticide sprays, paraffin wax and lubricating oils; to residues, which give us wood preservatives, tars for paving streets and airports, coke and emulsifiers.

Newer distillation units pass the petroleum vapors into a "bubble tower," divided into a number of sections. Substances such as heavy oils with higher boiling points condense in the lower sections and flow down through the tower. The hot gases from the furnace bubble through these liquid products and the gasoline fraction passes out at the top of the column and

is condensed separately. Other fractions are withdrawn at different levels. A variety of products may be made by separating and purifying these various fractions.

Catalytic cracking is often used to break down petroleum molecules and rearrange them chemically so as to produce more of certain desirable constituents. "Cat cracker" chemicals come

in three sizes: lumps, granules, and a powder fine enough to be handled as a fluid.

The "cat crackers" do not turn out 100-octane gasoline as a finished product, but produce the base stock for aviation fuel. When 100-octane gas is taken out, however, less remains for the numerous byproducts made from petroleum.

► PIPELINES are welded into continuous arteries for industry's life fluid—Yale Pipe Line from Elk Basin Field, Montana.





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A number of these "cat crackers" have been built during the war. The production of 100-octane gas has been increased ten-fold since 1942.

The octane number of gasoline is measured by the tendency of the fuel not to knock in use. One of the pure hydrocarbon components of petroleum, iso-octane, was discovered earlier to be free of knocks in the highest compression motor it was then possible to build. Another component, normal heptane, was found to knock under almost any circumstances. A fuel-rating scale was thus made with heptane as zero and pure iso-octane representing 100. Gasoline falling between these extremes is rated as if it had a certain percentage of iso-octane, the rest being the knock-creating heptane.

Much of the 100-octane gas today is

made by taking iso-octane mixed with tetraethyl lead (which, incidentally, has an octane number greater than a hundred) and blending it with gas which is rated below 100.

Geologists agree that there are still huge quantities of undiscovered oil beneath our land. We will even end the war with more known oil reserves than before Pearl Harbor because new fields have been found. Engineers have already demonstrated that we can derive synthetic crude oil at reasonable cost from the great reserves of natural gas and the tremendous deposits of oil shale, of tar sands, and of coal and lignite. Oil which can be derived from these sources is believed by many to be enough to supply our needs at the present rate of consumption for more than a thousand years to come.

► *THE chemist in the grease laboratory of the Standard Oil Development Company at Bayway, N. J. (photograph on opposite page) is examining a polybutylene which is blending into an oil. Pictorially he symbolizes the way in which science is blended into the oil industry through research. The striking pictures of this article and the back cover are by courtesy of the Standard Oil Co. (N.J.) and its staff of photographers.*

Back Cover Photograph

► *THE ARRAY of apparatus shown on the back cover of this issue is used to extract butadiene from cracked gases. Butadiene is one of the two essential chemicals for synthetic rubber production. This is a part of the Baytown Refinery of the Humble Oil and Refining Co., the panorama of which is shown on page 1.*

Mud Conquered Chemically

by HARLAND MANCHESTER

► SCATTERED through a dozen states and an unknown number of battle areas are stretches of unpaved road, air strips and parking areas which are behaving as dirt never behaved before. They do not get muddy when it rains. Not so long ago they were ordinary dirt roads which were churned by traffic into hub-deep mush during wet seasons. They still look like ordinary dirt roads when they are dry. But when it rains the water slides off into the ditches or evaporates, refusing to penetrate the surface.

The ground has actually been waterproofed by a chemical method discovered only a few years ago, when it was found that a small quantity of resinous material, thoroughly stirred into a depth of a few inches, would render most types of soil water-repellent. The possibilities are so great that the Corps of Engineers, the Army Air Forces and the Navy have commandeered all of the chemical they can get. And at home the Civil Aeronautics Administration and a number of state highway departments are testing small areas with a view to postwar use. The CAA is interested in hundreds of small airports that can be made permanently mud-free, and the highway departments see a better future for our 2,000,000 miles of dirt roads.

Last summer at a new airport near Philadelphia a radio shack was built in a potato field; after a rain the 200-

foot approach to the building was a miry mess. When the road had dried out it was plowed and disked, and the resinous powder was spread on the surface and worked in. Then the road was graded and rolled. A two-day job, it worked like a charm. Near Hattiesburg, Miss., there is a chemically waterproofed dirt road which has remained dry and firm through several seasons of torrential rains. The invisible tarpaulin was spread over a dirt road in an English war-plant area. Heavy lorries have pounded it for months, but it is mudless even in blinding downpours. Thoroughgoing experiments are being conducted at Vicksburg, Miss., by the Corps of Engineers.

"Soil stabilization" is the name of the new science of treating earth so that it will not absorb water and will remain firm regardless of weather. For several years chemists and highway engineers have been testing various materials for making soil stay put. Leader in the field is Dr. Hans Winterkorn, founder and director of the new Soil Science Laboratory at Princeton University and soil stabilization expert of the Civil Aeronautics Administration and the U.S. Highway Research Board.

Dr. Winterkorn, a saber-scarred Heidelberg alumnus, left Germany in 1931, got a teaching position at Missouri State University, and became a

citizen. Always a soil expert, he found a challenge in Missouri mud, and got on the right track through a seemingly unrelated problem in Florida citrus groves. Certain soils there would not absorb water, and the trees were dying. This soil apparently contained a waterproofing agent, but in amounts too small to be detected by chemical analysis. Nonetheless, Dr. Winterkorn followed up the clue. He tested dozens of inexpensive resins, soaps and bituminous materials for their stabilizing effect upon various soils when mixed with them in minute quantities. He found that a number of resinous powders would waterproof surface soil when mixed with it in a ratio as low as 1 to 200. This discovery was exciting, but it was only the beginning.

Dr. Winterkorn soon had disciples, and his papers were widely read. Two years ago Princeton called him to set up its soil stabilization laboratory. He arrived with two of his Missouri students and several tons of Missouri dirt which he had tested and labeled for use as yardsticks. The laboratory has now become scientific headquarters for the new method of treating soil. Not all soils behave alike, and so sacks of dirt arrive from everywhere for exposure, after being mixed with various resins, to laboratory-created extremes of artificial weather.

One resin, made from the sap of southern pine stumps, has been tested extensively by the Hercules Powder Company, which has produced a resin called Vinsol, first used to improve the wearing quality of concrete. Soon it was found that this resin, highly concentrated in a powder called 321, would waterproof 200 times its volume of earth. It was difficult to make a suffi-

cient quantity of the pure resin for war use, so it was made to less rigid specifications and mixed with Portland cement. The result, an easy-to-use waterproofing powder, is called Stabinol. The added cement is not enough to form a hard surface, but by aiding the coagulation of clay particles it increases the water-repelling action of the resin.

Only a year old, Stabinol has been so effective in combating mud on military roads and airports that the entire output has been taken over by the Government. From 1½ to 6 pounds of this powder, depending on the nature of the soil, is used to treat a square yard of earth to a depth of about six inches. This invisible coating not only sheds rain but destroys the capillary action which pulls water from the subsoil to the surface of ordinary dirt.

Stretches of dirt road in Delaware, Florida, Georgia, South Carolina, Panama, French Guiana and many other localities have been fitted with this new chemical raincoat. After the surface is harrowed, trucks pass along and drop bags of the powder at the correct intervals. The bags are opened and pulled across the road, distributing the powder evenly. The powder is mixed in by disking, and the ground is graded and rolled.

It is too early to be sure how long the treatment will last, but experts predict that in mild climates it will banish mud for many years. As an added dividend, the chemical control of surface moisture discourages grass and weeds. This should make it useful for unpaved factory yards and railroad rights of way. It should be ideal for keeping postwar clay tennis courts

mudless and weedless throughout the summer.

Meanwhile Dr. Winterkorn and his associates have carried on research with other highly concentrated waterproofing agents. Excellent results were obtained from a mixture of aniline (derived from petroleum and coal) and furfural, a chemical with plastic properties made from oat-hulls. But most promising of all is a resin made from tall oil.

Tall oil is made from a liquid residue of the pulp-making process. When pine wood is ground up and cooked to make the sulphate pulp used for wrapping paper and cardboard boxes, quantities of a residue called "black liquor" is drawn off. This stuff was once discarded as worthless, and there were many complaints about the pollution of streams. For years the Swedes had reclaimed the soapy scum which rises to the surface of this liquid, to make from it what they called "tallolja" (oil of pines)—translated as "tall oil." The thick, brown, viscous oil is valuable as an ingredient of soap and is used in paints and varnishes as a quick-drying agent.

This waste of valuable chemicals interested Drs. C. B. F. Young and K. W. Coons, two chemical students from Alabama who met at Columbia University in the middle '30's. They worked out a new, economical method for refining the oil and tried to interest capital. When the war came, demand for the oil increased, and two years ago, with WPB approval, they formed the National Southern Products Corporation and set up a plant in Tuscaloosa, Alabama. The development of the new soil waterproofing resin has given them a fresh spur.

Mixed with dirt in a proportion of one to 200, this new powder makes a highly effective raincoat. Briquettes made of earth treated with it in Dr. Winterkorn's laboratory have been soaked in water seven days without losing their shape. The resin is being tested on flight strips and roads by the engineers of the Army Air Forces, and large-scale manufacture is about to begin.

The Alabama partners have also produced a dust-laying chemical from tall oil. It is inexpensive—from 10 to 15 cents a gallon—and so powerful that a gallon of it, mixed with ten gallons of water, is enough to treat more than a hundred square yards of dusty road. This, too, is being tested by the Army. The raw material for these resins is cheap and abundant. The ceiling price of crude tall oil is two cents a pound, and great quantities are still going to waste in the pulp factories.

It would be a mistake to assume that anyone can sprinkle any road with "magic powder" and forever end the mud nuisance. Soils must be analyzed and experts must apply the stabilizer. No known resin will waterproof sand, and alkaline and acid soils react differently. The methods described are intended for light traffic only. To stand up long under heavy traffic, roads must be paved. But there is every reason to believe that great mileages of back roads can be made mudless and dustless.

Chemical stabilization is not limited to dirt roads and airports. It is valuable for keeping a roadbed dry when laying a concrete pavement. Chemical waterproofing costs less than it would to rework the roadbed in case of rain, and

there is no delay while waiting for it to dry. It is also used to waterproof building sites to prevent construction delays caused by rainfall.

Another possibility lies ahead—the goal of using blocks of hard, chemically stabilized earth as a cheap material for the construction of houses. Attractive experimental houses have already been built at Arlington, Va.,

with hard, durable walls made of plain earth stabilized with a little cement or emulsified asphalt. Some of the newly developed chemicals are much more powerful binders. In the manufacture of plastic articles, such highly active resins have the same effect in consolidating rags, paper, sawdust and other “extenders.” So these resins used to defeat mud may eventually launch an era of plastic houses and plastic roads.

Cow's Stomach Is Vitamin Factory

► A cow's STOMACH is a vitamin factory, capable of turning out not only enough B-complex for her own needs but a surplus that is excreted with her digestive wastes. This fact, originally discovered in researches at Pennsylvania State College some 15 years ago, is again engaging the attention of scientists.

Specifically, the part of the cow's complex stomach where vitamins are produced is the pouch known as the rumen. The vitamin manufacture is not accomplished by the body processes of the cow herself but by swarms of bacteria living in the rumen, working on the often low-vitamin diet on which the animal feeds.

Vitamin benefits from the cow's digestive processes have been known in a crude fashion for a long time: it is a common barnyard observation that skinny, runty chickens “perk up” if they have a chance to scratch for chance grains in a heap of cow manure.

Conclusive evidence that vitamins of the B-complex are synthesized by bacterial action in cows' rumens was obtained in 1928 by S. I. Bechdel and

associates, J. F. Shigley, Hannah E. Honeywell, R. Adams Dutcher, and M. H. Knutsen. They had found previously that young calves make normal growth on rations shown to be vitamin B-complex deficient in tests on rats.

Penn State Jessie, a cow which achieved great public interest because of the window in her side, figured largely in these vitamin B synthesis tests, supervised by Dr. Bechdel. Quantities of partially digested feed were removed through this opening for chemical and bacterial analysis.

Subsequent experiments at other stations have shown that a cow produces sufficient of the B-complex vitamins for her own needs from feeds low in this constituent, and if properly fed, excretes large quantities which may be used by other animals.

Scientists and feed manufacturers now are concerned with the problem of how to include the B vitamin eliminated in cow manure in feeds for other forms of livestock without offending customers or an over-sensitive public. The source of vitamin B fed may be quickly forgotten, however, if superior animal products result.

Superficial Knowledge Necessary

by DR. FRANK THONE

➤ ISN'T IT ODD, how our knowledge of things stops at their surfaces!

All we ever see of anything is the outside of it. We can only infer what's inside. If we cut anything open, to find out what the inside is like, we turn the inside into additional outside. If we thrust in a probe of any kind, from a simple finger to a complex electrical or optical instrument, we are only pushing in a deep dent of the outside surface, and keeping it in contact with our probing instrument. We are still not inside.

Take the simplest of imaginable cases: You want to find out what the inside of a stone or iron ball is like. You saw it in two, exposing its very center. But what have you? It is no longer a sphere but two hemispheres, with two new, broad, circular outside surfaces that weren't there before. You can repeat the process indefinitely, until you have ground the original sphere to powder, and all you will have done is increase the total area of outside surfaces myriad-fold, without ever having got actual inside knowledge of even the smallest bit of the iron or stone. And if you duplicate the process on the most complex of plants or animals, you'll find the same thing happening. Every incision you make only exposes a fresh surface; you don't know what the now-separated parts

were like before the scalpel intruded and rudely destroyed their oneness.

This is a baffling state of affairs; but perhaps for practical purposes it doesn't matter greatly. Apparently just about all biological and chemical processes of importance to us take place at surfaces. Iron rusts on the surface only, a piece of meat in your stomach gets digested from the outside inward, even so fast a reaction as the burning of a gunpowder grain takes place on its rapidly dwindling surface.

The whole modern science of catalytic chemistry, on which such tremendously important industries as petroleum refining and synthetic plastics depend, is an affair of surfaces. If you examine some of the catalysts used in commercial processes you will find that one thing they all have in common is a great deal of surface. They usually come either in powdered form or as tiny porous pellets, which have a great deal of "internal" surface. These vast areas of finely divided surface offer convenient meeting-places to the atoms, ions or molecules that are to be combined, for whatever chemical handclasps are required before their final union.

In the literal sense of the word, therefore, the most modern phases of chemistry require the intensest kind of superficial knowledge.

The Story of the Kitchen Match And How It Came To Be

Man Strikes Fire

by STUART LITTLE

► THE KITCHEN MATCH is a useful but undecorative household necessity which retails for 1/72 of a cent. In this streamlined era it wears a nostalgic, Gay-Nineties look that belies its modernity. But behind this little sliver of wood with its bulbous, bi-colored head is the drama-packed story of man's centuries-long search for a portable light, a convenient fire to carry on his person.

Prior to the late 1700's there had been no practicable way of producing fire save by the flint-steel-tinder method or by a fire drill comprised of a bow and shaft of wood rotating in a cup of wood. True, Hennig Brandt had discovered phosphorous in 1669 while brewing an alchemistic formula for homemade gold, but this easily ignited element had remained chiefly a curiosity. In 1680 Godfrey Hankwits began the manufacture of phosphorous in London, retailing it at the equivalent of \$250 an ounce, current U. S. currency.

In the same year Robert Boyle discovered that, by coating coarse paper with the phosphorous, fire could be produced by drawing sulfur-tipped splinters through a fold. The prohibitive price narrowed Boyle's customer list to the very wealthy and the interest in phosphorous dimmed. About a century later there was a flurry of inventions of fire-making contrivances. From France, in 1781, came the phos-

phoric candle or ethereal match which consisted of a bit of frayed waxed paper tipped with phosphorous in a sealed glass tube. When the owner knocked the end off the tube the paper flamed as the air reached it. The pocket luminary (Italy, 1786) was a bottle lined with momentarily ignited phosphorous which coated the inside walls with a film of oxide. A splint tipped with sulfur, if rubbed against the oxide film, lighted when withdrawn from the bottle.

The instantaneous light box which appeared in 1805 survived for 40 years, despite its obvious dangers. Like the pocket luminary, it involved a small bottle—this one containing sulphuric acid. The splints were treated with a composition of potassium chlorate, sugar and a binding such as gum arabic or acacia. Termed *Empyryon* or *Oxymuriated Matches* in the extravagant fashion of the day, these lights were popular in the United States for a while, retailing at \$2 for 50 splints. An interesting modification, aimed to intrigue the very lazy, appeared in 1824. The patentees pointed out to prospective customers that one could get a light while lying in bed simply by pulling a cord which opened a box, pulled the bottle stopper and ignited the splint. A second tug on the cord lighted a small lamp.

Last of the novelties that preceded the match was one called the electro-

pneumatic fire producer which involved the principle of the ignition of a fine jet of hydrogen gas by means of a spark from a piece of charged rosin. The chemist, Dobereiner, produced the best-known of several forms of the fire producer. His hydrogen gas, generated by the action of dilute sulfuric acid upon zinc, was directed in a thin jet upon a platinum sponge in contact with the air. A flame resulted which burned until shut off or the supply of gas was exhausted. One of the surviving models created by this German inventor shoots the gas from a cigar held by the statue of a man, standing on a generating cylinder.

While Dobereiner was making this elaborate electropneumatic fire producer, across the channel in England an apothecary and chemist, one John Walker, had made and sold to a Mr. Hixon "100 Sulphurata Hyperoxygenata Frict." and a tin case to hold them. That sale, dated April 7, 1827, is the first record of a transaction involving friction matches.

Later analysis showed that Walker's matches, each three inches long, were tipped with potassium chlorate, antimony sulfide, gum and starch and were ignited by drawing them through a folded sheet of "glass paper."

In 1829, Walker's matches were exhibited in London and an enterprising young chemist named Samuel Jones, noting that their inventor had not patented the processes, immediately set himself up in business, calling his product "Lucifers." Jones retailed his matches in boxes which contained a sheet of friction paper.

Ignition was accompanied by small explosions which showered sparks on the user and, when sulfur was added

to the original combination to accelerate burning, the resulting odors were so offensive that Jones printed this admonition on his boxes: "If possible, avoid inhaling gas that escapes from the combustion of the black composition. Persons whose lungs are delicate should by no means use lucifers."

The dissonance sounded by Mr. Jones thus early was not the last. Matchmaking and heartache were to walk hand in hand from the early 1800's until nearly a century later when William A. Fairburn, a smart young American chemist, practicing modern alchemy, produced the non-noxious, non-poisonous match that American factories today turn out by the billions.

Chief of the heartaches of the industry began in 1830 with the invention by Dr. Charles Sauria of France of the phosphorous match. The curious element which Godfrey Hankwits had hawked at fantastic prices to his opulent clientele in 1680 was now substituted for antimony sulfide in the Walker-Jones formula.

Alonzo Dwight Phillips, a powder maker of Springfield, Mass., was granted an American patent in 1836 describing "new and useful improvements in modes of manufacturing friction matches for the instantaneous production of light." The composition used by Phillips was, he specified, "phosphorous, chalk and glue."

The basic chemical nature of the phosphorous match did not change for nearly 70 years. There were some changes in the chemical combination of the head; paraffin was substituted for sulfur as a flame transmission agent; heads were moisture-proofed and splints were impregnated to pre-

vent the fire hazards of lingering embers or afterglow.

But just as the basic chemicals remained unchanged so remained the basic and deadly by-product of phosphorous match manufacture—necrosis.

Many called it, jocularly, "Phossy jaw," but it was not at all funny to the workers who contracted it or to the children who were incapacitated or died as the result of eating the heads of the matches.

By 1900, the original match machine invented in 1888 by Ebenezer Beecher had been improved by the Diamond Match Company to close to its 1,125,000-an-hour clip of today. But this modernization had not been matched by a corresponding abatement of necrosis, by then an accepted occupational hazard in the industry.

In France, Henri Sevene and Emile David Cahen had patented a match formula which substituted sesquisulfide of phosphorous for the deadly phosphorous, an improvement which eliminated health hazards for worker and consumer alike. The Diamond Match Company purchased the patent for \$100,000 in 1900.

From 1900 to 1903, the company's chemists tried to adapt the French formula to American-made matches. Expert after expert was brought from abroad. Climatic conditions such as humidity and temperature balked production of an efficient match. More than half of the matches actually made were returned by the trade. They were erratic, struck hard but chiefly, just wouldn't light.

The formula was regretfully laid aside as hopelessly unsuited to American conditions. Phosphorous necrosis

continued and American anger mounted. By 1909 even the government was taking official notice.

It was at this moment that William A. Fairburn joined the Diamond Match Company as engineer. He invented and installed a pioneer air conditioning system that eradicated the offending phosphorous fumes, arranged for compulsory free medical service for employees. From that date there was not another case of necrosis in any of Diamond's many factories.

In 1910 Mr. Fairburn discovered the discarded French formula. He was determined to make it work. He created formulae by the hundreds, made matches from them, retained the features he liked. By the end of the year he had several workable compositions. Early in 1911, Diamond was ready to produce its strike-anywhere, non-poisonous match.

Meanwhile the clamor against the phosphorous match had risen to such proportions that Congressman John J. Esch had drawn a bill, taxing these matches so heavily that they could no longer be manufactured at a profit.

In effect, the bill would have put every match maker in the United States out of business except Diamond which would have had a monopoly in the non-poisonous match field. However, Edward R. Stettinius, father of the present Secretary of State and president of Diamond in those days, handed the patent to rival companies and instructed his chemists to instruct competitors in using Fairburn's formula.

Mr. Fairburn's persistent inventiveness coupled with the subsequent generosity of his company was rewarded some years later when Mr. Fairburn, by then president of Diamond Match

himself, was awarded the Louis Livingston Seaman Medal of the American Museum of Safety for "progress and achievement in the promotion of hygiene and the mitigation of occupational disease."

So, unglamorous as it appears, the

modern match is the result of a search for improvement which began when that first remote ancestor awoke on a cold wet morning to find his fire dead and no convenient way to get it going again; it is the product of generations of chemists and inventors, each adding a little toward its perfection.

New Approach to Home Building Needed

► **BETTER HOMES** will be built when the building industry stops trying to make improvements by imitating present buildings and building materials and starts anew, carefully studying the possibilities of using processed materials, the engineering problems incidental to their use, and how they may be used most economically. They should study the experience of the aircraft industry, for instance, in which plywood has been largely replaced by resin-bonded woods, engineered and produced for final end use.

This is the opinion of Robert L. Davison, housing research consultant for the Wood Industries Division of the American Society of Mechanical Engineers, in a paper prepared for presentation at the meeting of the division that was cancelled in compliance with the government's ban on conventions.

Building-material manufacturers blindly accept the traditional stud wall, he says, as representing the functions to be performed by a dwelling wall, and seek to develop substitutes for products as used in this wall. They do not stop to consider whether the present wall is designed to perform its functions. They do not list in quanti-

tative terms the qualities a wall, or other building element, should have, and then engineer their material or develop new materials to meet these specifications.

"The fact that the functional-design approach has been used with great success by virtually every industry but the building industry should," he states, "at least cause a re-examination of the thinking underlying developments in the building field."

Processed materials referred to by Mr. Davison include rigid-type insulation board, plaster board, sheet metal and sheet glass, all of which may be produced more cheaply by machinery than by hand methods. Various forms of corrugated sheet metal, when used alone on a skeleton frame, he cited as another example of a processed wall.

The hardwood laminate floor developed and used by the Tennessee Valley Authority is mentioned by Mr. Davison as one of the early examples of a processed building element. It is made on a machine that turns out a continuous ribbon of laminated floor material which does not require subflooring. It is completely finished at the plant and has sufficient stiffness to permit wide spacing of floor joists.

Thousands Saved From Poor Diet Ills: Making Doughnuts Better

Nutrition News and Hints

by JANE STAFFORD

► THOSE OF YOU who have been struggling to stretch your meat and fat ration points will be interested in two lists of foods providing the dietary allowances nutrition authorities recommend. They are in terms of low-cost, every day types of foods. List Two was prepared for populations where milk and meat supplies may be restricted.

The lists were given by Dr. Charles Glen King, scientific director of the Nutrition Foundation, in one of the New York Academy of Medicine lectures to the laity. These lectures have now been published under the title, *The March of Medicine*, by Columbia University Press. By comparing these two lists, you may get some new ideas of how to give your family nourishing food when meat supplies are short. Here are the lists:

LIST I

- Milk—1 pint
- Eggs—1 daily, if possible
- Meat, fish or fowl—1 or more servings
- Potato—1 or more
- Vegetables—2 or more servings. One green or yellow
- Fruits—2 or more. One citrus fruit or tomato or other good source of vitamin C
- Cereals and bread (wholegrain or enriched)
- Other foods as needed to complete the meals.

LIST II

- Turnip greens—1 cup
- Sweet potatoes—3
- Peanuts—20 nuts or 2 tablespoons of peanut butter
- Beans or cowpeas—1½ oz.
- Tomatoes—1 cup
- Corn meal—3 oz.
- Enriched flour—3 to 4 oz.
- Milk (fresh, evaporated, or dried)— $\frac{1}{3}$ qt.
- Lean pork—small serving 3 to 4 times a week.
- Molasses, fat, etc., to complete the meals.

Thousands Rescued

► WEAK, DIZZY, bedridden, often pain-racked and crazed victims of poor diet came by the thousands last year to the Nutrition Clinic at Hillman Hospital, Birmingham, Ala., Dr. Tom D. Spies, associate professor of medicine at the University of Cincinnati and founder and director of the Nutrition Clinic it maintains at Birmingham, reported to the Spies Committee for Clinical Research.

More than half of those who had severe pellagra would have died and one-tenth of those who lived would have spent their remaining years in mental hospitals in 1930. But in 1944 there was not a death among the 5,845 patients with deficiency diseases in the Nutrition Clinic.

More than 2,000 physicians, nurses,

chemists and nutritionists from all over the nation watched these suffering men, women and children recover when the specific diet lack that caused their illness was discovered and remedied.

The visiting scientists saw thousands more sent elsewhere for treatment because their painful neuritis, eye trouble or insanity was not caused by nutritional failure and could not be treated at the clinic. The tests, examinations and careful questioning about diet habits by which diet deficiency disease or nutritional failure can be detected even when typical signs are lacking were all demonstrated.

For Dr. Spies believes and hopes that tens of thousands who can not come to the Nutrition Clinic and may never hear of it can, through its service as a demonstration center, be saved from death, insanity and the wretched, poverty-stricken existence that may be caused by nutritional failure.

"Few physicians," he said, "realize the meticulous clinical study needed before a diagnosis of deficiency disease is justified. The science of nutrition has advanced so rapidly that the practicing physician wonders what he can include as valid in his day-to-day practice of medicine. Since the Nutrition Clinic was first established, we have felt that we should make every effort to clarify the subject for the physician and to promote wider application of earlier and better methods of treating nutritional deficiency diseases. We are trying to serve as an auxiliary to everyone interested in promoting better nutrition."

Enriched Doughnuts

➤ DOUGHNUTS, with triple the popular appeal they had in 1929, seem now to

be making a bid for favor on the nutritional score. That appears to be the story back of a scientific study of vitamin losses during deep fat frying reported by Dr. Gladys J. Everson and Dr. Arthur H. Smith, of Wayne University, Detroit.

When the Red Cross and other organizations hand out doughnuts and coffee to men in the armed forces, nutritionists wish they could give something as tasty and easy to serve that contained more vitamins and minerals. And nutritionists generally advise all of us to eat a better breakfast than one consisting solely of doughnuts and coffee. The doughnuts contribute calories for energy, but the doughnut and coffee breakfast is short of vitamins and minerals.

White bread for breakfast toast used to have the same nutritional fault of lacking vitamins and minerals. Now it is enriched by addition of three B vitamins, thiamin, niacin and riboflavin, and the mineral, iron.

Why not enrich doughnuts, too? is the question naturally asked by those who make them and those who like to eat them. One answer was that the deep fat frying by which doughnuts are made would cause a loss of thiamin, which does not survive heat well.

In a study supported by a grant from the Doughnut Corporation of America, Drs. Everson and Smith found that when doughnuts are made by the usual commercial process from enriched flour, which is one way of making enriched bread, there was lost 22.9% of the thiamin and 20% of the niacin but no appreciable amount of riboflavin or of iron.

Some thiamin is lost from bread in baking. The average loss is about 15%,

but the 22.9% loss reported for the doughnuts is within the range reported for thiamin loss in bread. Niacin, the pellagra-preventing vitamin, however, is not lost in the baking of bread as this vitamin stands up well under heat.

Waste of vitamins, because of the loss in processing, has been one argument against enriching doughnuts, crackers, cake, spaghetti and macaroni.

The number of doughnuts eaten by the average person also comes into the picture. Drs. Everson and Smith state that in 1929, according to sales records, 201 millions of dozens of doughnuts were sold. In 1943 the figure was 665 millions of dozens. In 1944 the Red Cross distributed 84,130,960 doughnuts, approximately, to members of the armed forces in all theaters. That is a lot of doughnuts, but if divided equally it would come to less than a dozen doughnuts a year for each GI and one a week for each of the 130,000,000 or 140,000,000 persons in our population.

Even leaving out infants and non-doughnut eaters, some nutritionists think doughnuts do not constitute a large enough part of the daily diet to make enrichment advisable. The average person consumes much more bread than doughnuts daily, it is argued, so bread is considered the product to be enriched from the standpoint of improving national nutrition.

GIs and others in the services who may consume a large proportion of the 665 million dozen or more annual doughnut fry probably will continue to get their doughnuts, enriched or

non-enriched, there being no satisfactory substitute. Maybe someone can work out a substitute full of vitamins in time for the next war.

Spinach

➤ SIGNS that spinach may get back into favor with nutritionists, if not with small boys, appear in a report by Dr. Roe E. Remington and Dr. Cecil L. Smith of the Medical College of the State of South Carolina.

Junior could, if he would, eat as much as two and three-quarters pounds of spinach daily without having his growth stunted or his bones malformed, so long as his diet is not short in calcium, if the scientists' studies with rats can be transposed to humans.

Chief objection to spinach by nutritionists had been that some substance in it, presumably oxalic acid, interfered with the utilization of calcium for bone formation. In the course of experiments testing the availability of iodine in certain vegetables, Drs. Remington and Smith had occasion to feed a commercially prepared powdered spinach to young rats on a diet that for years had been successfully used as a breeding ration. They decided at the same time to test the effects of the spinach on growth and bone formation.

The rats ate daily what would amount roughly to two and three-quarters pounds of spinach in a human dietary of 2,500 calories. No decline in appetite or efficiency of food utilization was noted, their growth was not stunted, and there was no harmful effect on their bones, where calcium deficiency would show up.

Theater programs that may be read in the dark are a possibility in postwar days; either the paper or the ink will contain phosphorescent pigments.

Chemical Things to Do

How To Drill Holes In Glass

by JOSEPH H. KRAUS, *Science Clubs of America Editor*

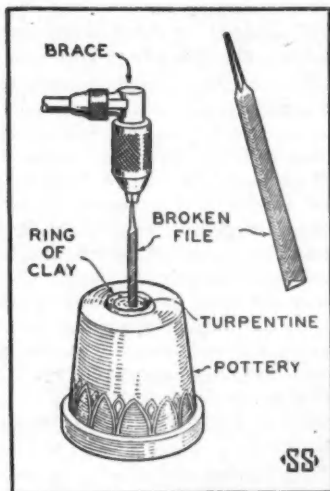
➤ A **BROKEN FILE**, lubricated with turpentine and turned like a drill in a brace, will cut a nice hole through a sheet of glass or glazed pottery.

Holes in glass often are needed to make glass cases bound together at the corners with metal straps. Similarly, holes can be made in glass disks for use in the construction of a static machine, or the same method may be employed for making openings in the bottoms of colorful, glazed pottery. The pottery then can be used for house plants, where the holes provide drainage. An outstanding bit of pottery can be converted into a lamp, the wires supplying current being strung through the drilled holes.

An otherwise useless triangular file forms the cutting tool. Just put the end of a file in a vise or straddle it across two small metal blocks and break it sharply with a blow from a hammer. The break, of course, will not present a smooth surface. One side will probably be a trifle longer than the other.

Fasten the file between the jaws of an ordinary brace. If the tang is too long, break it off. The jaws of the brace can be opened wide enough so that the file can be gripped firmly.

Set the file on the material which is to be drilled and moisten well with ordinary spirits of turpentine. In fact, it is better to make a small well of putty and pour the turpentine into this well. Apply medium pressure.



At first, you will think that you are making no progress, but don't quit. After a while you will find the file cutting much better. The reason is that it will take quite a while to break through the glazed surface and produce a satisfactory bite. Occasionally raise the file a bit to permit the lubricant to get under the end of the cutting tool.

Drill From Both Sides

As soon as the smallest hole has been worn through the material being drilled, turn the work piece upside down and drill from the opposite side. Failure to do this may result in cracking the inside surface.

When the file becomes dull, do not attempt to sharpen it. Instead just break off another short piece from the end of the tool.

Knowing how to do this will enable you to build many different bits of scientific apparatus for use in your

home laboratory. You can make a china or glass plate for a vacuum chamber, a drilled slab of glass for a hand microtome, a drilled bottle to serve as a condenser or gas generator and drilled plates to cover aquariums.

Ambassadors Helped Check Typhus

► AMBASSADORS joined with scientists and Army and Navy Medical and Sanitary Corps officers in the fight against typhus fever, latest awards of the United States of America Typhus Commission Medal show.

The Honorable Alexander Comstock Kirk, U. S. Ambassador to Italy, and the Honorable Laurence A. Steinhardt, U. S. Ambassador to Turkey, are among the recipients of this award announced by the War Department. The awards were made by the War Department at the direction of the President.

Mr. Kirk, as Minister to Egypt during the period from Jan. 7, 1943, to May 1, 1944, took great personal interest in the activities of the commission. His constant support of its program "contributed materially to the success of the commission's investigations and control of typhus fever in the Middle East," his citation "for exceptionally meritorious service" states.

Mr. Steinhardt, also cited for "exceptionally meritorious service," besides his active cooperation with the commission and support of its efforts to control typhus fever in Turkey, "personally made possible a cooperative project with the Turkish Army Medical Department which advanced the appreciation of American medicine in Turkey and fostered scientific

understanding and good will."

The vaccine used to protect American fighting forces against typhus fever and DDT, the powerful killer of lice which spread typhus, have been justly acclaimed, especially for their roles in the control of the epidemic in Naples last year. Besides these weapons, the fight against typhus required organization and administration and laboratory studies. Meritorious service along these lines was given by others receiving the Typhus Commission Medal. They are: Capt. Thomas J. Carter, M.C., U.S.N., Chief, Preventive Medicine Division, Bureau of Medicine and Surgery, Navy Department, whose home address is 2910 North 24th St., Arlington, Va.; Col. Harry Poltz, M.C., A.U.S., 671 East 17th St., Brooklyn, N. Y.; Lt. Col. John Crayton Snyder, M.C., A.U.S., 535 East 72nd St., New York City; Lt. Comdr. William B. McAllister, Jr., M. C., U.S.N.R., 2385 Euclid Heights Blvd., Cleveland, Ohio; Maj. Charles M. Wheeler, Sanitary Corps, A.U.S., 200 West Imperial Highway, Brea, Calif.; Maj. Theodore E. Woodward, M.C., A.U.S., 1 Park Ave., Westminster, Md.; Lt. Comdr. Andrew Yeomans, M.C., U.S.N.R., 38 Webster Place, Brookline, Mass.; Capt. Byron L. Bennett, Sanitary Corps, A.U.S., 14 Autumn St., Boston, Mass.

Fungicides Save War Equipment Damaged by Moist Heat

'Tropicalization' Fights Mold Damage

► AMONG the enemies our armed forces in the Pacific have to face are fungi, microscopic lower plants that thrive on heat and dampness. The battle against these enemies, carried on at headquarters of the Air Technical Service Command at Wright Field, Ohio, and by Wilfred F. Horner and Helen Conlon, biologists of the Belmont Radio Corporation, will continue to benefit persons in tropical regions after the war is over.

Extreme difficulties have been encountered in Pacific and other combat areas, due to effects of tropical deterioration of electronic equipment, including radar radio communication and other devices. This menace was so severe that new methods of moisture and fungus control were necessary in order that the progress of the armed forces might not be impeded.

Laboratory research and field investigations, based upon experience in certain regions such as Florida and the Gulf and Pacific coasts, have resulted in a new technique called tropicalization. This endeavor undertakes to prevent failure of equipment due to moisture and fungus growth. Tropicalization can increase the life of equipment over 100 times.

Fungi that attack electronic equipment are molds which obtain their nutrition from deposits of organic dust that collect during handling. These molds produce organic acids, such as citric acid or oxalic acid. They grow

best in a relative humidity above 70% and in temperatures above 86 degrees Fahrenheit.

In addition to attacking electrical equipment, some of these molds are parasitic on the human body. For example, a species of *Aspergillus* grows on radar equipment and also grows in the human ear. The number of species for each genus of fungus is astonishing. There are, for example, 36 species of *Aspergillus* and over 600 species of *Penicillium*.

Some of the fungi that develop in the field equipment in the tropics are introduced in the United States at the time of assembly but do not develop until the temperature and humidity are increased. The extent of damage to electronic equipment varies with the type of equipment and the conditions under which it operates. Such units and materials as condensers, resistors, transformers, volume controls, various types of plastics, glass, oils, waxes, paints, papers, leather, felt, glues and rubber support numerous fungus growths. Eight species of tropical fungi were isolated from a growth on a pair of eyeglasses.

Fungicides in the form of fine liquid sprays, coatings and paints, as well as the vacuum impregnation of parts with waxes, lacquers and varnishes containing fungicides, have been developed to combat the menace. Among the fungicides that have given favorable results are pentachlorophenol and salicylanil-

ide, in concentrations of 10% or 15% on the basis of solids content. The fungicides that have been tested are developed to protect against moisture and fungus growth without altering the basic features of materials such as elec-

trical properties, tensile strength and so on."

Water repellents and drying agents are also used in packaging, to prevent the introduction of excess moisture in transit.

The Growth of Chemical Ideas

► A REVIVAL of scientific interest in the physico-chemical study of reactions is foreseen by Dr. C. E. Kenneth Mees, vice president and director of research of the Eastman Kodak Company, at the 500th meeting of the Rochester, N. Y., Section of the American Chemical Society.

"I believe that these reactions are more likely to be those of the carbon compounds than those of the other elements on which physical chemistry has been so largely centered up to the present," Dr. Mees said.

"It has always seemed to physical chemists that the synthetic organic chemists neglected the possibilities for the application of physical chemistry to the reactions which they were studying, and I still feel that the wedding of these two great fields of chemistry might prove a very fruitful union."

In the field of organic chemistry, great changes have occurred in the last twenty years, Dr. Mees pointed out.

"The techniques of synthesis which were developed toward the end of the 19th century," he explained, "were satisfactory to the organic chemists as long as they were dealing with the compounds derived from benzene or from the heterocyclic ring structures, which, to some extent, simulate the properties of benzene; that is, as long as organic chemistry used as its base

materials the oils derived from coal tar.

"But after the first world war, the great oil refining and manufacturing companies of the United States started to study the possibility of using petroleum products as the base for new groups of organic compounds, and the attention of the manufacturing chemists became concentrated on the aliphatic organic compounds—those composed of chains, originally short, of carbon atoms and derived from acetylene, natural gas, or the decomposition products of petroleum.

"With these compounds, it was found that reactions could be produced with great facility in the gas phase, using catalysts which might be solids, liquids, or even gases. As a result, the classical aliphatic chemistry which we learned at school has largely ceased to have any relation to manufacturing processes.

"You all remember, for instance, the preparation of acetic anhydride by the treatment of acetyl chloride with sodium acetate. The Waucher process for manufacturing acetic anhydride, which is used on such a large scale bears little relation to that classical reaction.

"In the Waucher process, acetic acid is catalytically decomposed in the gas phase at a very high temperature to ketene (CH_2CO), the inner anhydride

of acetic acid, and the ketene then reacts with the molecules of acetic acid to form acetic anhydride. More and more reactions of this type are taking the place of the classic organic synthesis and are placing in our hands at a low cost large quantities of chemicals which used to be chemical curiosities.

"Many of these new chemicals have a double bond in their structure; that is, they are unsaturated, and this double bond confers on them the power of polymerization, since the molecules of the substance can link together at the double bond and form chains or networks of molecules leading to compounds having very high molecular weights. Such compounds were already known in nature; and the glucose molecules, for instance, polymerize to form starch and cellulose.

"By this means, chemists have built up a large group of so-called plastics—compounds having a high molecular weight and usually valuable elastic properties, more comparable with the natural products which have been of such value to man throughout the ages, products such as wood, wool, cotton, and glass. The study of the plastics and of high molecular compounds generally is now a very important branch of chemistry and the ideas involved in the structure of polymers are just coming to the front in modern chemical theory.

"These new ideas, which are closely associated with those I referred to a short time ago as dealing with the valence bond, represent perhaps the most fertile field for chemical investigation in the near future."

Dr. Mees stressed the importance of craftsmanship in science, citing Berzelius as an outstanding example. "It is, I think, insufficiently recognized both by practicing scientists, and still more, by their teachers, that experimental science, and particularly chemistry, depends for its success very largely on skilled craftsmanship and that this can only be acquired by a very large amount of practice," he declared.

"In holding this doctrine, I am, of course, following in the tradition of the school where I was trained. At University College, London, Ramsay continually stressed the importance of great amounts of laboratory practice. He carried this, indeed, possibly to excess by regarding attendance at lectures as of little value; and as soon as he could free a student from routine work, he assigned him to experimental work which would keep him continuously in the laboratory.

"Skill in chemical manipulation takes a long time to acquire even for those who are naturally gifted, and an over-concentration in teaching courses on the written and spoken word is likely to result in the graduation of a man who knows what has been written about chemistry but who will find himself in the greatest difficulties when he is called upon to practice chemistry for his livelihood.

"There was little risk that the students of Liebig would get insufficient practice in the laboratory, and, indeed all chemical work at that period was carried out by those who loved the practice of the subject and who found their greatest joy in the manipulation of the laboratory."

Researches Hint Two Different Chemicals May Be Involved

Preventing Tooth Decay

► TWO RESEARCHES have produced suggestions that two different chemicals may be involved in the complex problem of tooth decay.

Tryptophane

► MAYBE SOME DAY in the future we will be able to keep our teeth from decaying by using toothpaste or chewing gum containing tryptophane or by swallowing regular doses of this chemical in the form of tasteless white crystals.

This possibility appears in a report by Mrs. Naomi C. Turner, of Radcliffe College. The essential amino acid tryptophane, she finds, has distinct promise as a preventive agent for dental caries.

Amino acids are protein building blocks. Certain of them are called essential because the body cannot synthesize them and must have them for growth and health.

Tryptophane's promise of preventing tooth decay is based on the finding that it slows down the rate of starch decomposition. In a previous study of 51 patients at the Forsyth Dental Infirmary Mrs. Turner and E. M. Crane had found a correlation between starch decomposition by the saliva and the amount of caries, or tooth decay, in the mouth. Persons with 20 or more cavities produce saliva which decomposed, or hydrolyzed, starch very rapidly. Persons with little or no tooth decay produce saliva which hydrolyzes starch very slowly.

The finding that a high protein (low carbohydrate) diet has a favorable

effect on caries and other findings led Mr. Crane to suggest looking to the amino acids for a material that delayed starch hydrolysis by the saliva.

Mrs. Turner has already tried the effects of doses of tryptophane in one person. Within a week, the time required for starch hydrolysis by this person's saliva had increased from a base rate of 20 minutes to 240 minutes. Whether tooth decay will be prevented, Mrs. Turner says, remains to be established.

Ordinarily, studies of a number of patients would be made before reporting results, but, Mrs. Turner states, she is reporting consistent studies of one individual at this time in order that interested research workers may undertake simultaneous studies on the effects of tryptophane in reducing tooth decay.

Best dosage and best way of giving the chemical will also have to be determined in future studies.

Ammonia

► IMMUNITY to tooth decay, or caries, comes from tiny amounts of ammonia continuously present in the mouth, it is suggested by findings reported by Dr. Robert G. Kesel, Joseph F. O'Donnell and Ernst R. Kirch, of the University of Illinois Colleges of Dentistry and Pharmacy.

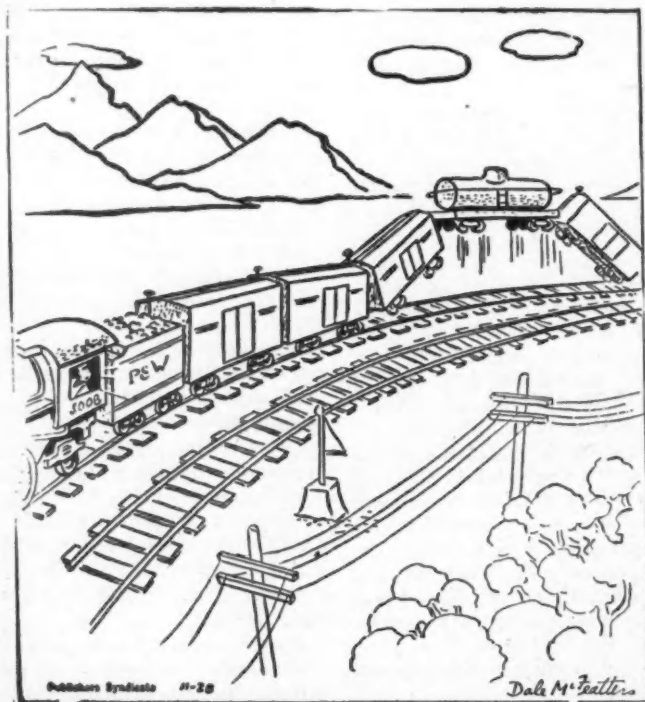
The ammonia is present specifically in the patch of material on the tooth surface which acts as lodging for bacteria, known as the bacterial plaque. The ammonia comes from a small

group of amino acids, protein building blocks, which are in the mouth as a result of the type of diet and body metabolism, the scientists report.

The lucky persons who are immune to caries have in their salivas enzymes capable of producing ammonia from certain amino acids, according to the findings of the Illinois group. Many enzyme systems were also found in salivas from persons with actively decaying teeth, but in most instances these salivas did not have an enzyme

system capable of converting glutamic acid to ammonia.

The presence of ammonia in saliva was reported some years ago by another group of scientists, Drs. C. T. Grove and C. J. Grove. Its significance, however, was not appreciated. Search for the reasons why persons without tooth decay have no acid-forming bacteria in their mouths and why their salivas do not rapidly convert sugar into acid led the Illinois group to discovery of the role of ammonia.



"That carload of helium is tryin' to take off again!"

Latest Chemical Patents

by DR. FRANK THONE

► A POWERFUL EXPLOSIVE, useful for blasting and demolition purposes, is made out of a substance that hardly rates as an explosive at all, simply by dusting it with a finely powdered mild explosive and setting it off with a small booster charge of TNT. The basic substance is ammonium nitrate, widely used as a fertilizer and in chemical manufactures; the dusting is done with nitro-starch, to the extent of from 0.5% to 3% by weight. A little adhesive of some kind (even corn syrup can be used) helps the two to stick together.

The new, low-cost, easily-made explosive is described in U. S. patent 2,371,000, issued to Dr. Walter O. Snelling, research chemist of the Trojan Powder Company, to which concern rights in the patent are assigned.

Secret of success in getting the usually inert ammonium nitrate to rip itself apart with destructive violence seems to be in the even distribution of the provoking explosive, and the chemical pace-setting by the booster charge of TNT. The very fast detonation wave started by the TNT, helped along by the nitro-starch, travels at its initial rate through the entire charge.

Polymerized Silicones

► SILICONES, the new family of organic compounds of silica that have already created a considerable stir in chemical society, are joined by a group of new members described in patent 2,371,050, obtained by Dr. James F. Hyde, of

the laboratories of the Corning Glass Works, to which he has assigned patent rights.

Dr. Hyde polymerizes silicones, with the addition of other chemical elements, to make new resin-like substances of remarkable physical properties, ranging from tough and rubbery to hard and brittle, with high resistance to both heat and electricity. As an example, phenyl ethyl silicon, used as an impregnating agent in glass-fiber cloth, produces an insulating material of double the electrical resistance of standard varnished cloths now on the market.

Sterile Food in Bags

► SOMETHING NEW in chemical food preservation methods is offered by Francis K. Baerwald of Berkeley, Calif., for patent 2,370,768. Instead of using a germ-killing preservative that stays permanently in the food, perhaps injuring its quality, he uses a highly volatile substance, such as ethylene oxide or methyl bromide. The food is packed in bags of Cellophane or Pliofilm, which are permeable to the vapors of these substances, so that after they have killed the molds and fungi present they soon vanish without a trace. The well-sealed film covering, however, prevents any further entry by spoilage organisms.

Safer Powder Manufacture

► SAFER MANUFACTURE of smokeless powder is the objective of processes on

which two Hercules Powder Company chemists, Bernhart Troxler and Leon W. Babcock, have taken out three patents, Nos. 2,370,130, 2,370,209 and 2,370,271; rights in all three are assigned to the employing firm.

The first two patents cover the use of inert gases, such as nitrogen, helium or carbon dioxide, as an atmosphere in the closed vessels in which all steps of manufacture are carried out. This is to minimize the danger of accidental ignition, always present when atmospheric oxygen is present. The third patent is on a large, bin-like apparatus into which the powder is introduced, after formation into grains, for its final steps of cleaning and drying, which at present involve several separate handlings, with transfers from building to building.

Electron Microscope

► **TECHNICAL SPOILS** of war are represented in patent 2,370,373, for it is on an invention by enemy aliens; the patent is vested in the Alien Property Custodian, from whom American manufacturing rights may be secured upon payment of a nominal fee. The invention is an electron microscope, of much more compact design than the German devices in this class have hitherto been. Electron source, vacuum pump and all other necessary parts are built into an integral whole, instead of being essentially separate portions rather laboriously assembled.

Patentees are listed as Ernst Ruska, Helmut Ruska, Hans Schuchmann and Heinz Otto Mueller, all of Berlin.

Continuous-Flow Fermentation

► A CUBAN INVENTOR, Francisco Alzola of Havana, has received patent 2,371,208 on a continuous-flow process for the production of industrial alcohol,

with which he proposes to replace the traditional batch process. His apparatus consists of a series of vats or tanks, into the first of which he introduces the mash of molasses or other carbohydrate, together with the necessary yeast. As fermentation proceeds, the working mash is passed from vat to vat, until maximum alcohol concentration is reached in the last one, when it is withdrawn for distillation.

Lignin for Storage Batteries

► **LIGNIN**, the wood constituent long regarded as a kind of unemployable chemical tramp, has another job offered it in patent 2,371,137, taken out by J. A. Orsino of Westfield, N. J., and Carlyle Harmon of Wausau, Wis., assignors respectively to the National Lead Company and the Marathon Corporation.

Compounds of lignin with the sulfonic acid radical have been found very useful in the negative plates of storage batteries because they are highly resistant to the action of the sulfuric acid that is one of the prime causes of battery degeneration.

One of the patentees, Mr. Harmon, has taken out another patent, No. 2,371,136, on another phase of the same general process.

War-Born High Explosive

► **NOISIEST** and most violent of the chemical infants born of the present war, a mixture of TNT with the even more powerful stuff known for short as PETN, is covered by U. S. patent 2,371,879, issued to two duPont chemists, Dr. Clyde O. Davis and William E. Kirst. Pentolite is the name by which the mixture has come to be popularly known.

PETN, which is pentaerithritol tetranitrate when spelled out in full, is

too "touchy" by itself for safe handling under ordinary field conditions. However, when from 5% to 40% of it is dissolved in hot TNT, the mixture retains the insensitivity to shock that makes TNT the almost ideal high explosive, yet is practically as violent in its detonation as "straight" PETN. Pentolite has been much used in bazooka projectiles and other missiles. Rights in the patent are assigned to E. I. du Pont de Nemours & Company.

Lead Coating for Steel

► Du Ponts are also the assignee of patent 2,371,725, taken out by James H. Young of Niagara Falls, N. Y., on a new method for applying a coating of lead to sheet steel. The steel is first given a light coating of copper, then dipped in a bath of molten lead. Thus coated, the steel becomes good material for roofing, lining chemical fume chambers, and other uses where high resistance to corrosion is valuable.

Magnetic Separation

► A HARVARD faculty member, Prof. John Wulff, offers a method for magnetic separation of pure iron particles from those containing carbon, as subject of patent 2,371,665. Purest possible iron is needed in powder metallurgy; too high a carbon content interferes with proper sintering.

Prof. Wulff's process depends on the fact that at a certain critical temperature carbon-containing iron becomes much less magnetic than pure iron. Heated to this temperature, the finely powdered iron is flowed over a magnetic separator. The pure iron particles stick, while the carbon-contaminated ones fall off.

Plastics for Textiles

► THERMOPLASTIC compounds of the

vinylidene chloride series are used in rendering textiles resistant to the attacks of fungi, insects and other spoilage organisms, in the process on which patent 2,371,618 was issued to A. W. Hanson and W. C. Goggin, both of Midland, Mich. Impregnation is carried out under both heat and pressure; a high degree of permanency is claimed. Patent rights are assigned to the Dow Chemical Company.

Powdered Fuel

► A NEW EFFORT to utilize coal dust, sawdust or other powdered solid fuels in internal combustion engines is represented by patent 2,371,618, granted to William J. Caldwell of Independence, Mo. The fuel is dumped into a hopper, whence it is carried into an air-mixing chamber by means of a toothed feed wheel. A blower projects the mixture of fuel and air into the cylinder.

Floating Soap

► A NEW and very simple method for preparing floating soap, on which patent 2,371,175 has been granted to Charles W. Kelley of Duck Hill, Miss. Most floating soaps have air whipped into them, in larger or smaller bubbles; this requires special machinery. The present invention contemplates the use of bubbles of carbon dioxide. These are generated by the addition to the melted soap mass of a small quantity of sodium bicarbonate, which "fizzes" on contact with the soap's ordinary mildly acid constituents.

Flask for Gases

► A NEW-TYPE flask for gases under high pressure is offered by Daniel Mapes of Rutherford, N. J., for patent 2,370,677. A tight wrapping of piano wire is wound over the outside of the

cylinder, for the purpose of preventing an explosive rupture if struck by a bullet or shell fragment. The device is intended primarily for use in combat planes. Patent rights have been assigned to the Specialties Development Corporation.

Mosquito Oil

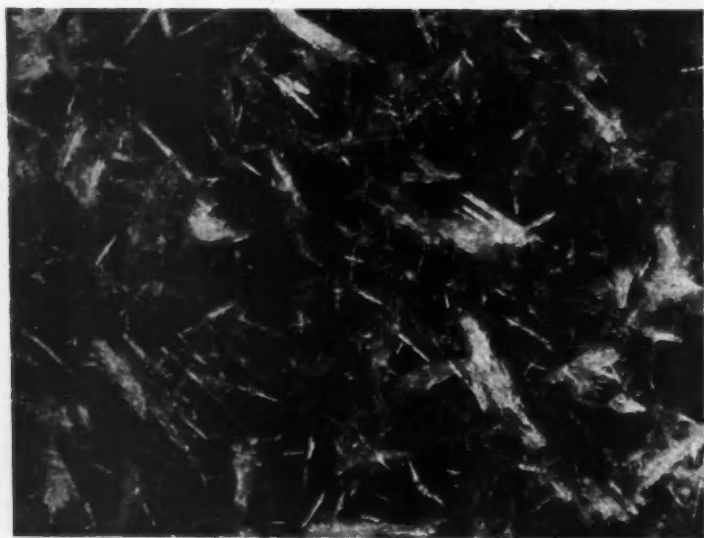
► A SPECIAL OIL for fighting mosquitoes and other pests that breed in water is the subject of patent 2,370,881, issued to T. G. Roehner and assigned to the Socony-Vacuum Oil Company. It has a specific gravity as great as or greater

than that of water, so that some of it settles to the bottom while the rest forms a film on top. It can be made from crude petroleum, coal or lignite.

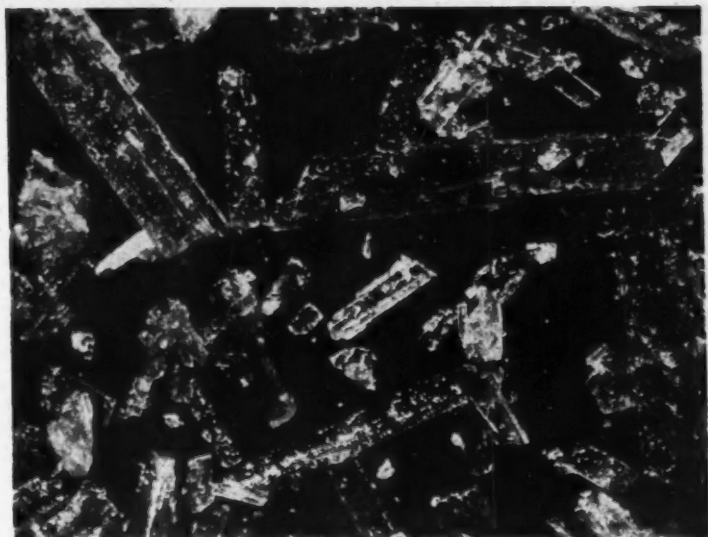
Magnesium Alloy

► A NEW magnesium alloy, said to be useful for pistons, cylinder heads and other parts of airplane engines, is covered by patent 2,370,320, granted to Cresap Moss of Salt Lake City. It contains about five per cent each of nickel and manganese, the balance being pure magnesium. Patent rights are assigned to the Chicago Development Company.

The electronic technique of radio-frequency heating is now applied to penicillin production and greatly speeds the process.



Galol



Gadol

New Vitamin A Discovered In Shark Liver

► DISCOVERY of a new vitamin A, twin to the one already known, is announced by C. D. Robeson and J. G. Baxter of the Laboratories of Distillation Products, Inc., Rochester, N. Y.

They suggest calling these vitamin twins Gadol and Galol. Gadol comes from the Latin word for codfish and is given to the vitamin A which has long been known and was isolated in pure form about five years ago. Galol is derived from the word for shark, the fish from whose liver the second vitamin A was first isolated.

Existence of Galol has been suspected for some time but it eluded de-

tection because it is present in smaller proportions in most fish liver oils. Its crystals are quite different in shape from those of the previously known vitamin A and it differs in some other respects, but it has similar potency as a vitamin. The two vitamins are believed to be geometric isomers.

Vitamin A is required for normal growth and health. Lack of it may lead to serious changes in the eye, including night blindness, and in other tissues of the body. Fish liver oils are the chief source of the vitamin, but foods such as carrots, sweet potatoes and green leafy vegetables furnish carotene which the body can convert into vitamin A.

Penicillin at Drug Stores

➤ **PENICILLIN** for civilian use is now on sale at drug stores. The War Production Board has lifted restrictions on the life-saving mold chemical and made it available through normal trade channels to all hospitals and physicians.

It is put up in form for hypodermic injection for your doctor to give you. There is not yet enough of the material for use in manufactured products such as pills, ointments, lozenges and other forms which the layman might use himself. If and when it becomes available in such form, the Food and Drug Administration will decide whether it may be sold without a doctor's prescription.

At least 1,500,000 vials, each containing 100,000 units, are being made available. The 2,700 civilian hospitals that had been getting penicillin through special arrangement with WPB prior to general release had been using about 400,000 vials a month. (From 5,000 to 40,000 units are needed in each injection, depending on the illness.)

Don't Waste Penicillin

➤ **EVEN THOUGH** there is now enough penicillin for general civilian use as well as for the armed forces, there is not enough of it to waste any. Use of the precious mold chemical in conditions which it does not remedy would be a waste.

Experience with over 5,000 cases which have been carefully studied under the auspices of the National Research Council and the Office of

Scientific Research and Development show that penicillin is good for the following conditions:

1. All staphylococcal infections with and without blood stream involvement including acute and chronic osteomyelitis, carbuncles and soft tissue abscesses, meningitis, cavernous or lateral sinus thrombosis, pneumonia, empyema, carbuncle of the kidney, wound infections, burns and endocarditis (a form of heart disease).

2. All cases of clostridia infections, which includes gas gangrene.

3. All hemolytic streptococcal infections with invasion of the germs into the blood and all serious local infections. The list of these conditions includes cellulitis, mastoiditis with brain involvement, pneumonia and empyema, childbed fever, peritonitis and endocarditis.

4. Childbed fever and local infections due to anaerobic infections.

5. Meningitis, pleurisy and endocarditis due to pneumococci and all sulfa-drug-resistant pneumococcal pneumonias.

6. All gonococcal infections, including those complicated by arthritis, eye trouble, endocarditis, peritonitis and epididymitis.

7. All cases of anthrax.

8. All cases of chronic pulmonary suppuration in which operations are contemplated.

9. All meningococcal infections in which sulfa drugs fail.

10. All cases of bacterial endocarditis in which the heart trouble is due to germs susceptible to penicillin.

Syphilis is listed as a condition in which penicillin has been found effective but its position not definitely defined.

Some illnesses are not benefitted by the drug. Influenza, tularemia, undulant fever, tuberculosis, acute rheumatic fever, acute and chronic leukemia, malaria, infantile paralysis, virus infections and cancer are listed, along with a number of less familiar ailments, as conditions for which penicillin should not be used because it does not have any effect on the illness.

Penicillin Price Drops

► THE COST of being sick, when the illness is one that responds to penicillin, is going down.

The price of the drug itself has dropped, since the general release for civilian use, from \$2.40 per 100,000 Oxford units to as low as \$1.54 per 100,000 units. This last figure is a wholesale price and the price to a physician may be \$1.80 to \$2.00 per 100,000 units.

This amount, 100,000 Oxford units, is enough to cure one case of gonorrhea. Most other illnesses require considerably more of the drug, depending on how early treatment is started and how severe the illness is. For syphilis two to four million units may be required. For osteomyelitis, a bone infection that is usually long drawn-out, as much as five million units may be needed. From 500,000 to 1,000,000 units are required for most illnesses in which penicillin is the drug of choice.

The price of sulfa drugs, which can be used for some of the same condi-

tions as penicillin, is less than the price of penicillin. The cost of getting well may be cheaper when penicillin can be used, however, because recovery is quicker. This means less time in the hospital, a smaller bill for the hospital room or bed, and a quicker return to work and earning.

Sulfa drug treatment, however, can sometimes be given at home. The patient does not have to be stuck with a hypodermic needle every three or four hours a day and night, as he does when undergoing penicillin treatment. The method of giving penicillin requires more visits by the doctor or more nursing attendance, which is likely to be reflected in the total cost of the illness.

Penicillin Pills

► PATIENTS taking penicillin in future may swallow the drug in a pill, or rather a gelatin capsule, instead of getting it by hypodermic injection, it appears from studies reported by Dr. Raymond H. Libby, of the American Cyanamid Company's research laboratories, in the journal, *Science*.

It has not heretofore been possible to give the mold chemical by mouth because its activity is so rapidly destroyed by the acid in the stomach. Dr. Libby reports he has overcome this difficulty.

Sodium or calcium salts of penicillin are suspended in cottonseed oil and then put into gelatin capsules. The gelatin capsule protects the penicillin from the stomach acid. The penicillin then becomes available through absorption into the blood from the small intestine.

Tests with animals and patients showed that the capsule method of giving penicillin is effective in keeping

adequate concentrations of the drug in the blood for action against invading disease germs.

More penicillin apparently must be used but this, Dr. Libby suggests, will probably be offset by several factors. One is the greater ease, for both doctor and patient, of giving the drug by mouth instead of by injection. Another is that less highly refined penicillin should be satisfactory. This would simplify production procedures.

Penicillin By Mouth

► **HOPE** THAT in future patients can swallow their doses of penicillin instead of having them injected by hypodermic needle every three hours is increased by a report to the Journal of the American Medical Association here.

Penicillin by mouth was effective in a number of cases of gonorrhea and other diseases, Drs. Paul Gyorgy, H. N. Vandegrift, William Elias and L. G. Colio of Philadelphia, and F. M. Barry and J. D. Pilcher of Cleveland report.

With the penicillin, trisodium citrate was given to act as a buffer against the acid in the stomach. Destruction of the mold chemical by the stomach acid before it could get into the blood and achieve its healing effect has been the difficulty heretofore in giving it by mouth. Penicillin is sensitive to alkali as well as acid, so giving it with an alkaline antacid was considered impractical and undesirable.

The gonorrhea patients were cured in one to three days with doses of penicillin comparable in amount to those given by injection for treatment of this disease.

A three-year-old boy with chronic otitis media (running ear) had been getting sulfathiazole for 23 days with-

out any improvement. He was cured after 20 doses of penicillin with sodium citrate had been given by mouth every three hours, which would take two and one-half days.

Penicillin could be detected in the blood, some of the studies showed, four hours after it had been swallowed, whereas it is rare to find it in the blood even three hours after injection into the muscles.

Injections Reduced

► **THE** NUMBER of penicillin injections given patients can be cut from eight to three per day when the mold chemical is mixed with a special gelatin and a chemical of the kind used in nose drops, four University of Pennsylvania medical scientists report.

The scientists are: William M. Parkins, Marjorie Wiley, Jacob Chandy and Dr. Harold A. Zintel.

The number of injections of penicillin can be reduced because the gelatin and chemical delay the absorption of penicillin, letting it remain in the blood longer. It does not reach as high a peak concentration, however, and in some cases it may not be an advantage to have blood penicillin concentration kept at a constant level, the scientists point out.

The chemical used was of the type that constricts the small blood vessels. Two such chemicals, both popular for relief of stuffy noses in colds, were tried. Either of these chemicals alone or the gelatin alone was effective in maintaining blood penicillin levels. Chemical plus gelatin had an even better effect. The two chemicals tried were Privine (2 naphthyl-methyl imidazole hydrochloride) or Neosynephrine (laevo-alpha-hydroxy-beta-methyl-amino-3-hydroxy-ethylbenzene hydrochloride).

Need Transfusions Also

► BLOOD AND PLASMA transfusions are needed to complete the life-saving effect of penicillin, sulfa drugs and serum in severe pneumonia, four Boston physicians point out in another report to the Journal of the American Medical Association.

The four physicians are Drs. S. Howard Armstrong, Jr., Albert C. England, Jr., Cutting B. Favour and I. Herbert Scheinberg.

In two cases they report, penicillin stopped the pneumonia germs, but the patients became so anemic and so starved for protein that they almost died. One patient, an 85-year-old man who developed pneumonia after a prostatectomy, probably had been undernourished and anemic for some time before the operation and pneumonia. Badly fitting false teeth and poor appetite led to a diet consisting of tea, starches and sweets, with a daily eggnog and occasionally a small piece of pork.

In the other case, there was no sign of undernourishment before the pneumonia. The attack was so severe, however, and involved so much of his lungs that even though the germs were stopped by penicillin, the patient was "in desperate need" of treatment to relieve the difficulty in breathing and in getting enough oxygen into his blood to keep life going.

Such cases will be seen increasingly often, the Boston physicians believe, as powerful antibacterial drugs such as penicillin control germ infections that would otherwise be fatal. They suggest that in severe pneumonias physicians anticipate the development of anemia and deficiency of protein in

the blood and give blood and plasma transfusions and adequate protein in the diet early in the sickness.

Congenital Syphilis

► PENICILLIN may restore to health babies born with syphilis, it appears from studies in four university medical schools reported in the Journal of the American Medical Association. The report is signed by Drs. R. V. Platou and Allen J. Hill of Tulane, Norman R. Ingraham of Pennsylvania, Mary S. Goodwin of Johns Hopkins, and Erle E. Wilkinson and Arild E. Hansen, of Texas.

A total of 69 babies have been treated by the group. Of these, 39 have been followed for from four to 12 months. Twenty-five of these are now "physically normal" and blood tests are negative in 21, doubtful in four. Another nine of the babies are "also well" although their blood tests are still positive.

Clinical relapse in two and serologic relapse in five babies occurred. Five of the 69 babies died, three of them soon after or during treatment. These three had active syphilitic sores, were under two months of age and in poor general condition. Whether the two deaths five and 14 weeks respectively after treatment were due directly or indirectly to penicillin or syphilis is not known.

Best dosage schedules for penicillin treatment of congenital syphilis in infants, the doctors report, has yet to be worked out.

Strep Sore Throat

► PATIENTS with severe streptococcus sore throats start to improve within eight to 12 hours after the first injection of penicillin and are, as a rule, well within 24 hours, a group of Army

medical officers found in studies reported in the Journal of the American Medical Association.

Unless the patients continued to get penicillin treatment for six days, however, they suffered relapses.

The greater effectiveness of penicillin over sulfadiazine in throat infections with hemolytic streptococci is stressed in the report by Maj. Norman Plummer, Miss Dorothy Rhoades Duerschner, Maj. Harold Draper Warren, Capt. Francis T. Rogliano and Capt. Ruell A. Sloan.

"It should be used without delay in any serious, progressive hemolytic streptococci infection," they advise.

The most striking finding, they point out, was the disappearance of the streptococci from the nasopharynx within 24 hours. This raises a number of questions such as whether it is possible completely to eradicate the streptococci from the body and what effect this would have on the course of the disease and the development of rheumatic fever or kidney disease as complications of strep sore throat. The study does not answer these questions though it gave "some indication that complications of this disease can be

prevented and effectively treated."

New Strains of Mold

➤ GREATER amounts of anti-germ chemicals such as penicillin, streptothricin, streptomycin and the like, or even more powerful chemicals of this general type, may be obtained by means of the cyclotron, it appears from studies by Dr. William G. Myers and Miss Hazel Jean Hanson at Ohio State University.

About 100 new strains or mutations of *Penicillium notatum*, the mold from which penicillin is obtained, have been developed, they report in the forthcoming issue of *Science*. These new strains were obtained by bombarding the mold spores with neutrons from the cyclotron. These new strains differ markedly in rate of spore formation, anti-germ activity and other characteristics.

The possibility that new anti-germ substances are being produced by the mold as a result of the neutron bombardment is now being investigated.

New strains of the organisms that yield streptothricin and streptomycin are also being obtained by neutron bombardment but not as frequently as in the case of *Penicillium notatum*.

Epsom Salts Boosts Berry Vitamins

➤ EPSOM SALTS, old standby of the family medicine chest, can be useful as a horticultural fertilizer, reports Prof. W. L. Powers of Oregon State College.

The salts' chief value is in correcting a shortage of the essential element magnesium in certain soil types. Epsom salts, in the chemists' vocabulary, is magnesium sulfate.

In one test with the unusual fertilizer, a deficiency disease that caused blotched leaves on gooseberries was remedied. Yield of the berries was materially increased, and their content of vitamin C was found to be 24.4 per cent higher than that of berries grown on untreated soil of the same type.

Names of the Chemicals

by HELEN M. DAVIS

► CHEMISTS try to be very systematic about the nomenclature of the many substances they have to study. The main drawback to a thoroughly regular scheme is the fact that the names of many of the commonest chemicals, both elements and compounds, were household words long before the science of chemistry existed. Moreover, they were household words in different languages. In the literature of science, it is complicated enough to find one set of terms for all the distinctions of meaning that must be made. A separate set for each language is not desirable, to put it mildly. Which terms in common use should be kept, which replaced? Should modern roots be fitted with Latin endings? And which roots should be chosen?

About the beginning of the nineteenth century a great deal of thought was put into these problems of naming the chemicals. A few general principles were laid down, and the most practical compromises were made. One of the conventions adopted is that names of metals shall end in the Latin form, -um. Yet so many common metals were already known by common names that even this rule has to be tempered with common sense.

One of the most useful devices in chemical nomenclature is the chemical symbol, the letter or combination of two letters which stands for an atom of the element. Often this is the initial

letter of the element's name. Disconcertingly, some of the symbols seem to have no relation to that name at all. Usually the explanation for this difference is that the symbol is drawn from an earlier Latin name, once well known when Latin was in reality a universal language of the educated. Aurum was once the name for gold, hence Au. Argentum for silver gives us Ag. Fe comes from ferrum, which still appears in names of the two series of iron salts. The other symbols which look odd are: Na for sodium, from natron; K for potassium, from kalium; Cu for copper, from cuprum; Sn for tin, from stannum; Sb for antimony, from stibium; W for tungsten, from wolfram; Hg for mercury, from hydrargyrum; Pb for lead, from plumbum.

For the non-metals, there is no general scheme for the form of the name, except in the case of the halogens, fluorine, chlorine, bromine and iodine. Since these "salt formers" all end in -ine, Dr. Allison, who claims discovery of the fifth member of the Group, No. 85, has named it alabamine to conform to the names of the others.

Desirable as it may be to have a uniform method of naming elements, the early chemists wisely felt it even more important to show something of the structure of compounds by the form of their names. First they considered the simple salts, formed by

combination of a metal with one of the non-metallic elements. It was decided that the form of the metallic element's name would change if necessary to show differences in valence of the metal, and that the negative part of the molecule would take the suffix -ide to show this type of combination. Thus we have the oxide, the sulfide, the fluoride, the chloride, the bromide and the iodide. Some elements will form hydrides, carbides, nitrides and phosphides. Two radicals, those tightly bound groups of atoms which act together with properties suggesting those of elements, form, respectively, the hydroxide and the cyanide.

Ferrous chloride FeCl_2 and ferric chloride FeCl_3 are two salts distinguished by the valence of the metal iron, -ous meaning the lower valence (in this case, 2) and -ic the higher. Since combining with oxygen often raises the valence of an element, the term "oxidation" is frequently used to mean raising the valence by other means as well. The opposite term is "reduction."

Many of the non-metallic elements unite with oxygen to form negative radicals which combine with metals to make salts of a different constitution. To take sulfur as a typical example, it usually forms salts of sulfuric acid, H_2SO_4 . Such salts are sulfates. The suffix -ate signifies to the chemist that the sulfur is combined into a negative radical with oxygen, and that it is acting with its usual valence, which is higher than one it can sometimes exhibit. It is obvious that the suffix -ate saves a good deal of explanation.

When sulfur acts with that lower valence, the name of the acid is sulfurous, the formula is H_2SO_3 , and the

salts are called sulfites. But these two salts are not the only possible ones, so the chemist calls on those two Greek prefixes so common in scientific terminology, hypo- meaning below and hyper- meaning above. The salt in which sulfur shows its lowest valence is the hyposulfite. The corresponding acid is hyposulfurous, $\text{H}_2\text{S}_2\text{O}_4$. To make the names sound different, hyper- is frequently shortened to per-

Valence is often a confusing word to those whose knowledge of chemistry is gotten from books rather than from the laboratory. It is annoying that so many similar compounds exist and have to be memorized. The mechanism of atom nuclei and electron rings, with charges lost and won, seems hopelessly complicated. The laboratory worker is in better position, for he has in his test tubes materials which are obviously different, to his five senses. Words mean more when they are the names of substances that must be distinguished.

When the same substances, under different conditions, combine in different proportions to form different compounds, the chemist explains the differences in combining ability by saying that the valence (of one or more of the elements) has changed. He knows that the phenomenon is due to electrical forces in the atom, and can, if he wants to, draw a picture of the way he imagines electrons are shared by pairs or groups of atoms. The picture is complicated, takes a good deal of space and would look better in three dimensions. And it would not explain what he is trying to tell as well as the conventional structural formula.

The chemist writes his formulas in various ways. If he wants to express just the kinds and quantities of the

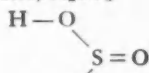
elements present, as though he were giving the results of an ultimate analysis, he writes the symbol of each element followed by a small subscript showing the number of atoms of that element in the molecule of the compound. This is known as the empirical formula. H_2SO_4 is an empirical formula.

It is like those tables you sometimes see, giving the composition of the human body in terms of so many quarts of water, so many pounds of coal, and a little of this and that, including enough sulfur and phosphorus to make a match book and enough iron to make a fair-sized nail. This is the ultimate analysis. It could be represented by an empirical formula for "protoplasm," if one wanted to stick one's neck out enough to sponsor the calculation. But not even in a Hollywood horror thriller would one expect to throw a nail and a match book into a bucket of coal and water, and pour out Frankenstein's monster after appropriate hocus-pocus. Yet the chemist wants the formula to tell him how to go about making the substance it represents.

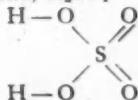
If he wants to stress the way the atoms are linked, to judge by the evidence of the way they react, the chemist may write the formula for sulfuric acid: $(\text{OH})_2\text{SO}_2$. It is unusual to write the simple formulas for inorganic compounds in this way, but the long chains of organic compounds are more and more coming to be written in terms of the groups of atoms which compose them. Ethyl alcohol may be written either as $\text{C}_2\text{H}_5\text{OH}$ or as $\text{CH}_3\cdot\text{CH}_2\cdot\text{OH}$. It is convenient to write $\text{CH}_3(\text{CH}_2)_n\text{OH}$ for the general formula for alcohols of the series.

To make the method of linking atoms still clearer, valence bonds are represented by short lines joining the symbols of the elements. The difference between sulfurous and sulfuric acids is well brought out by such a diagram:

Sulfurous acid, H_2SO_3



Sulfuric acid, H_2SO_4



According to current atomic theories, the valance is determined by the number of electrons in the outer ring of the atom, and these also determine the properties of the element which are responsible for its place in the Periodic Table. Therefore the highest number of valence bonds possible for an element is the same as the number of the Group in which it appears in the Table. Sulfur, in Group VI is thus expected to exhibit no higher combining power than 6. As a matter of fact, sulfur, and many other elements, form a great variety of compounds, in some of which it would simplify the writing of the formula to visualize the element acting at a higher valence than theory admits, but such compounds are always uncommon, and usually unstable, changing spontaneously into more ordinary arrangements.

When there are so many kinds of compounds to be differentiated that it is hard to find names for them all, various devices are used. With sulfur compounds, the prefix "thio-" meaning "sulfur," is used for some sub-

combination of a metal with one of the non-metallic elements. It was decided that the form of the metallic element's name would change if necessary to show differences in valence of the metal, and that the negative part of the molecule would take the suffix -ide to show this type of combination. Thus we have the oxide, the sulfide, the fluoride, the chloride, the bromide and the iodide. Some elements will form hydrides, carbides, nitrides and phosphides. Two radicals, those tightly bound groups of atoms which act together with properties suggesting those of elements, form, respectively, the hydroxide and the cyanide.

Ferrous chloride FeCl_2 and ferric chloride FeCl_3 are two salts distinguished by the valence of the metal iron, -ous meaning the lower valence (in this case, 2) and -ic the higher. Since combining with oxygen often raises the valence of an element, the term "oxidation" is frequently used to mean raising the valence by other means as well. The opposite term is "reduction."

Many of the non-metallic elements unite with oxygen to form negative radicals which combine with metals to make salts of a different constitution. To take sulfur as a typical example, it usually forms salts of sulfuric acid, H_2SO_4 . Such salts are sulfates. The suffix -ate signifies to the chemist that the sulfur is combined into a negative radical with oxygen, and that it is acting with its usual valence, which is higher than one it can sometimes exhibit. It is obvious that the suffix -ate saves a good deal of explanation.

When sulfur acts with that lower valence, the name of the acid is sulfurous, the formula is H_2SO_3 , and the

salts are called sulfites. But these two salts are not the only possible ones, so the chemist calls on those two Greek prefixes so common in scientific terminology, hypo- meaning below and hyper- meaning above. The salt in which sulfur shows its lowest valence is the hyposulfite. The corresponding acid is hyposulfurous, $\text{H}_2\text{S}_2\text{O}_4$. To make the names sound different, hyper- is frequently shortened to per-.

Valence is often a confusing word to those whose knowledge of chemistry is gotten from books rather than from the laboratory. It is annoying that so many similar compounds exist and have to be memorized. The mechanism of atom nuclei and electron rings, with charges lost and won, seems hopelessly complicated. The laboratory worker is in better position, for he has in his test tubes materials which are obviously different, to his five senses. Words mean more when they are the names of substances that must be distinguished.

When the same substances, under different conditions, combine in different proportions to form different compounds, the chemist explains the differences in combining ability by saying that the valence (of one or more of the elements) has changed. He knows that the phenomenon is due to electrical forces in the atom, and can, if he wants to, draw a picture of the way he imagines electrons are shared by pairs or groups of atoms. The picture is complicated, takes a good deal of space and would look better in three dimensions. And it would not explain what he is trying to tell as well as the conventional structural formula.

The chemist writes his formulas in various ways. If he wants to express just the kinds and quantities of the

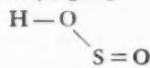
elements present, as though he were giving the results of an ultimate analysis, he writes the symbol of each element followed by a small subscript showing the number of atoms of that element in the molecule of the compound. This is known as the empirical formula. H_2SO_4 is an empirical formula.

It is like those tables you sometimes see, giving the composition of the human body in terms of so many quarts of water, so many pounds of coal, and a little of this and that, including enough sulfur and phosphorus to make a match book and enough iron to make a fair-sized nail. This is the ultimate analysis. It could be represented by an empirical formula for "protoplasm," if one wanted to stick one's neck out enough to sponsor the calculation. But not even in a Hollywood horror thriller would one expect to throw a nail and a match book into a bucket of coal and water, and pour out Frankenstein's monster after appropriate hocus-pocus. Yet the chemist wants the formula to tell him how to go about making the substance it represents.

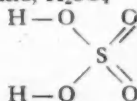
If he wants to stress the way the atoms are linked, to judge by the evidence of the way they react, the chemist may write the formula for sulfuric acid: $(\text{OH})_2\text{SO}_2$. It is unusual to write the simple formulas for inorganic compounds in this way, but the long chains of organic compounds are more and more coming to be written in terms of the groups of atoms which compose them. Ethyl alcohol may be written either as $\text{C}_2\text{H}_5\text{OH}$ or as $\text{CH}_3 \cdot \text{CH}_2 \cdot \text{OH}$. It is convenient to write $\text{CH}_3(\text{CH}_2)_n\text{OH}$ for the general formula for alcohols of the series.

To make the method of linking atoms still clearer, valence bonds are represented by short lines joining the symbols of the elements. The difference between sulfurous and sulfuric acids is well brought out by such a diagram:

Sulfurous acid, H_2SO_3



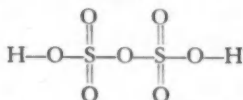
Sulfuric acid, H_2SO_4



According to current atomic theories, the valence is determined by the number of electrons in the outer ring of the atom, and these also determine the properties of the element which are responsible for its place in the Periodic Table. Therefore the highest number of valence bonds possible for an element is the same as the number of the Group in which it appears in the Table. Sulfur, in Group VI is thus expected to exhibit no higher combining power than 6. As a matter of fact, sulfur, and many other elements, form a great variety of compounds, in some of which it would simplify the writing of the formula to visualize the element acting at a higher valence than theory admits, but such compounds are always uncommon, and usually unstable, changing spontaneously into more ordinary arrangements.

When there are so many kinds of compounds to be differentiated that it is hard to find names for them all, various devices are used. With sulfur compounds, the prefix "thio-" meaning "sulfur," is used for some sub-

stances. Certain compounds, when they are heated, seem to combine with themselves, throwing off one molecule of water in the process. The new compound which results is often called "pyro-," as $\text{H}_2\text{S}_2\text{O}_7$, pyrosulfuric acid:



Sulfur forms a series of oxides which illustrate the use of Greek numerical prefixes. S_2O_3 is called sulfur sesquioxide, because there is one-and-a-half times as much oxygen as sulfur. SO_2 is sulfur dioxide, SO_3 the trioxide, SO_4 the tetraoxide. S_2O_7 is called the heptoxide, as it is the only one in which a seven appears in the formula.

The chemist has many materials to differentiate. The aim of schemes of

nomenclature is to distinguish between them clearly, with as little chance of confusion as possible. International committees work constantly to standardize names to further this purpose. The two chief offenders against such standardization work from motives which are understood but regretted by those who feel it unnecessary to learn three names for the same thing. One is the manufacturer who puts out his product under a brand name. If the name is a pleasing and pronounceable short word in place of a twenty-five syllable jaw-breaker formula, there is undoubtedly justification for one such name—but scarcely for five or six for the same compound. The other source of confusion is the author who thinks he simplifies his meaning by using a semi-obsolete term. "Muriate of potash" is no simplification of KCl .

Alkaline Salts Protect Cans

► **TIN CANS** resist rusting in outdoor exposure in hot humid weather when treated by a new process developed at the Battelle Institute, Columbus, Ohio. The process is the result of research here and in England to develop full protection for food for fighting men in parts of the world where ordinary treatment is not sufficient.

In the new method, after the cans are filled, sealed and processed, they are dipped momentarily into a hot solution of alkaline salts. This cleans the surface and produces an invisible film over the tin. No lacquer or enamel is used on the cans, as in present protective processes.

Lacquering tin plate to prevent rusting involves expensive and inconvenient operations in the manufacture of cans, it is explained. The hot alkaline process is readily adaptable to production lines in canneries. Protection against corrosion may not be quite as good as lacquers under some conditions, but it appears to be adequate for most purposes.

The mechanism of the new process is not definitely understood as yet. However, tests show that pinhole corrosion is effectively delayed and the cans stay bright and clean after weeks of outdoor exposure.

Acetate rayon fabrics may be given a permanent shine if a hot iron is used on them because too much heat melts the surface.

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Classics of Chemistry
Lime Was Just One Kind of Earth
Until Proved a Metallic Oxide

Metals From the Alkaline Earths

► HUMPHRY DAVY sent an electric current through ammonium-mercury amalgam and got hydrogen and ammonia gas out of it. This led him to believe that other amalgams might yield interesting results. Perhaps all elements could be proved to be compounds of hydrogen with something else. He tried out the alkaline earths, and discovered a series of new metals.

The first part of this classic is Davy's report at the time the discovery was made. The parts following describe the metals in the light of his later experience with them.

Ba, Sr, Ca and Mg

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ELECTRO-CHEMICAL RESEARCHES, ON THE DECOMPOSITION OF THE EARTHS; WITH OBSERVATIONS ON THE METALS OBTAINED FROM THE ALKALINE EARTHS, AND ON THE AMALGAM PROCURED FROM AMMONIA. By Humphry Davy. From *Philosophical Transactions of the Royal Society*. Read June 30th, 1808.

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To procure quantities of amalgam sufficient for distillation, I combined the methods I had before employed, with those of MM. Berzelius and Pontin.

The earths were slightly moistened, and mixed with one-third of red oxide of mercury, the mixture was placed on a plate of platina, a cavity was made in



SIR HUMPHRY DAVY

the upper part of it to receive a globule of mercury, of from 50 to 60 grains in weight, the whole was covered by a film of naphtha, and the plate was made positive, and the mercury negative, by a proper communication with the battery of five hundred.

The amalgams obtained in this way, were distilled in tubes of plate glass, or in some cases in tubes of common glass. These tubes were bent in the middle, and the extremities were enlarged, and rendered globular by blowing, so as to serve the purposes of a retort and receiver.

The tube after the amalgam had

been introduced, was filled with naphtha, which was afterwards expelled by boiling, through a small orifice in the end corresponding to the receiver, which was hermetically sealed when the tube contained nothing but the vapour of naphtha, and the amalgam.

In the best result that I obtained from the distillation of the amalgam of barytes, the residuum appeared as a white metal of the colour of silver. It was fixed at all common temperatures, but became fluid at a heat below redness, and did not rise in vapour when heated to redness, in a tube of plate glass, but acted violently upon the glass, producing a black mass, which seemed to contain barytes, and a fixed alkaline basis, in the first degree of oxygenation.

When exposed to air, it rapidly tarnished, and fell into a white powder, which was barytes. When this process was conducted in a small portion of air, the oxygene was found absorbed, and the nitrogene unaltered; when a portion of it was introduced into water, it acted upon it with great violence and sunk to the bottom, producing in it barytes; and hydrogen was generated. The quantities in which I obtained it were too minute for me to be able to examine correctly, either its physical or chemical properties. It sunk rapidly in water, and even in sulphuric acid, though surrounded by globules of hydrogen, equal to two or three times its volume; from which it seems probable, that it cannot be less than four or five times as heavy as water. It flattened by pressure, but required a considerable force for this effect.

The metal from strontites sunk in sulphuric acid, and exhibited the same characters as that from barytes, except

in producing strontites by oxydation.

The metal from lime, I have never been able to examine exposed to air or under naphtha. In the case in which I was able to distil the quicksilver from it to the greatest extent, the tube unfortunately broke, whilst warm, and at the moment that the air entered, the metal, which had the colour and lustre of silver, instantly took fire, and burnt with an intense white light into quicklime.

The metal from magnesia seemed to act upon the glass, even before the whole of the quicksilver was distilled from it. In an experiment in which I stopped the process before the mercury was entirely driven off, it appeared as a solid, having the same whiteness and lustre as the other metals of the earths. It sunk rapidly in water, though surrounded by globules of gas, producing magnesia, and quickly changed in air, becoming covered with a white crust, and falling into a fine powder, which proved to be magnesia.

In several cases in which amalgams of the metals of the earths, containing only a small quantity of mercury were obtained, I exposed them to air on a delicate balance, and always found that during the conversion of metal into earth, there was a considerable increase of weight.

I endeavored to ascertain the proportions of oxygene, and bases, in barytes and strontites, by heating amalgams of them in tubes filled with oxygene, but without success. I satisfied myself, however, that when the metals of the earths were burned in a small quantity of air they absorbed oxygene, gained weight in the process, and were in the highly caustic or unslaked state; for they pro-

duced strong heat by the contact of water, and did not effervesce during their solution in acids.

The evidence for the composition of the alkaline earths is then of the same kind as that for the composition of the common metallic oxides; and the principles of their decomposition are precisely similar, the inflammable matters in all cases separating at the negative surface in the Voltaic circuit, and the oxygen at the positive surface.

Undecomposed Bodies

THE COLLECTED WORKS OF HUMPHRY DAVY, Vol. IV: Elements of Chemical Philosophy, Edited by his brother, John Davy, London, 1840.

Barium

1. There is a mineral substance found in Cumberland, Yorkshire, and other parts of Britain, called Witherite, or carbonate of baryta. By dissolving this substance in dilute solution of nitric acid, evaporating the solution to dryness, and heating the salt obtained to whiteness, a light fawn-coloured powder is procured, which is baryta or barium combined with oxygen. To obtain *barium*, a quantity of this substance is made into a paste, with water, and placed on a plate of platina; a cavity is made in the paste to receive a globule of mercury; the mercury is rendered negative, the platina positive, by means of a Volatic battery, containing about 100 double plates.

In a short time an amalgam will be formed, consisting of mercury and barium. This amalgam must be introduced into a little tube made of glass free from lead, which must be bent in the form of a retort, filled with the

These new substances will demand names; and on the same principles as I have named the bases of the fixed alkalies, potassium and sodium, I shall venture to denominate the metals from the alkaline earths barium, strontium, calcium, and magnium; the last of these words is undoubtedly objectionable, but magnesium has been already applied to metallic manganese, and would consequently have been an equivocal term.

vapour of naphtha, and hermetically sealed. Heat must be applied to the end of the tube containing the amalgam, till all the mercury has been driven off; there will remain a solid difficultly fusible metal, which is barium.

2. I first gained indications of the decomposition of baryta, in the end of October 1807, and I obtained an alloy of it with iron, in March, 1808. The process of electrifying mercury, in contact with the earth, was pointed out to me in the course of my inquiries, by MM. Berzelius and Pontin of Stockholm, in May 1808; and in the beginning of June in the same year, I obtained *the metal*.

3. Barium, as procured by heating the amalgam, appeared of a dark gray colour, with a lustre inferior to that of cast iron. It was considerably heavier than sulfuric acid, for though surrounded by globules of gas, it sunk immediately in that fluid. It instantly became covered with a crust of baryta, when exposed to air, and burnt with a deep red light, when gently heated. When thrown into water it effervesced violently, disappeared, and the water was found to be a solution of baryta.

Barium as yet has been obtained only in very minute quantities. I have never possessed enough of it to ascertain its general chemical and physical characters, and no experiments upon it have been published by any other person.

4. From some results that I have obtained, it seems probable that barium may be procured by chemical, as well as electrical decomposition. When baryta, or the salt improperly called muriate of baryta, ignited to whiteness, was exposed to the agency of potassium, that metal being sent through it in vapour, a dark gray substance appeared, diffused through the baryta, or the muriate, not volatile, that effervesces copiously in water, and that lost its metallic appearance by exposure to air:—the potassium in this process was converted into potassa.

5. The only well-known combination of barium with oxygen is *baryta*, or *baria*. It is of a pale grayish green colour. Its specific gravity is about 4, that of water being 1. This substance is a non-conductor of electricity, has a strong caustic taste, reddens turmeric, and renders green vegetable blues. When acted upon by a small quantity of water, it heats violently, becomes white, unites to a proportion of water, and becomes a hydrate. The pure alkaline earth is infusible, except by an intense heat: the hydrate fuses at a strong red heat; a considerable part of its water is expelled by a still higher temperature. Baryta is soluble at 60°, in about 20 parts of water, and at 212° in about 2 parts. That baryta is composed of barium and oxygen, is proved by the combustion of barium in oxygen; in which as I have found, oxygen is absorbed, and no product but baryta formed. It is likewise proved syntheti-

cally by the action of barium upon water, in which case hydrogen is evolved; and analytically it appears from the action of potassium, on the earth. From indirect experiments, I am inclined to consider baryta as composed of 89.7 of barium, and 10.3 of oxygen: and supposing the earth to consist of one proportion of metal and one of oxygen, the number representing barium will be 130, and that representing the alkaline earth will be 145.

Barium, as would appear from the experiments of MM. Gay Lussac and Thenard, is capable of combining with more oxygen than exists in baryta. These able chemists state, that when baryta is gently heated by a spirit lamp, in a glass tube filled with oxygen gas, as absorption of the gas takes place. As yet no experiments have been made on the properties of this *oxide of barium*, or on the quantity of oxygen it contains; probably baryta may be easily combined with oxygen, by heating it with hyper-oxy muriate of baryta. The *hydrate of baryta*, if its composition be estimated from M. Berthollet's experiments, consists of one proportion of baryta, and one of water.

6. One combination only of barium and chlorine is known; it may be formed by heating baryta in muriatic acid gas, or in chlorine. In the first case, the oxygen of the baryta produces water by combining with the hydrogen of the acid; in the second it is expelled: and in an experiment made on purpose, I found that for every part in volume of chlorine absorbed, half a part of oxygen was given off from the alkaline earth. Hence it may be concluded that the compound of barium and chlorine contains one proportion of metal 130, and one of chlorine 67.

This substance is fusible by a very strong heat, is very soluble in water; its taste is bitter, its colour white, it is crystalline and transparent. It is improperly called in the French nomenclature, muriate of baryta. According to the principles of nomenclature which I have proposed, its name will be *barane*.¹

8. No other combinations of barium, except those with oxygen and chlorine, have been as yet examined; there can, however, be little doubt that its powers of combination will be, in many respects, analogous to those of potassium and sodium, as, of all metallic substances, it is the nearest related to these bodies.

9. The compounds of barium have as yet been applied to the arts in very few cases. Baryta is employed in small quantities, in the manufacture of certain kinds of porcelain; most of the salts containing baryta as a basis, are poisonous. The combination of baryta and carbonic acid, made artificially by pouring a solution of carbonate of ammonia, into a solution of nitrate of baryta, forms a pigment of a very pure white colour.

Strontium

1. *Strontium* may be procured precisely in the same manner as barium; carbonate of strontia, or strontianite, a mineral found at Strontian in Scotland, being used instead of witherite. I first procured this metal in 1808, but in quantities too small to make an accurate examination of its properties. It seemed very analogous to barium, had not a very high lustre, appeared fixed, difficultly fusible, and not volatile. It became converted into strontia by exposure to air, and when thrown

into water, decomposed it with great violence, producing hydrogen gas, and making the water a solution of strontia.

2. One combination of strontium with oxygen only is at present known; it is *strontia*, or strontites, the substance procured by burning strontium.² It may be produced in large quantities by igniting strontianite intensely with charcoal powder, or by heating to whiteness the salt formed from this fossil, by the action of nitric acid. It appears of a light fawn colour, and agrees in many of its characters with baryta. It is fusible only by an intense heat. Its specific gravity is between three and four, water being one. It is soluble in about 200 parts of water, at common temperatures, and is much more soluble in hot than cold water; its taste is acrid and alkaline, it reddens paper tinged with turmeric. When acted upon by a small quantity of water it becomes hot, its colour changes to white, and it is converted into a hydrate, and then becomes fusible at a white heat. From indirect experiments, I am disposed to regard it as composed of about 86 of strontium and 14 oxygen; and supposing it to contain one proportion of metal and one of oxygen, the number representing strontium will be 90, and that representing the earth 105.

3. No experiments have as yet been made on the direct combination of strontium and chlorine; but a substance which appears to consist of these two bodies, and no other elements, may be made, by heating strontia strongly in chlorine, or muriatic acid gas, or by igniting to whiteness the salt formed by the solution of stron-

¹ Chloride of barium.

² A peroxide may be obtained in the same manner as the peroxide of barium.

strontianite in muriatic acid. By the action of chlorine on strontia, oxygen is expelled: by the action of muriatic acid gas upon it, water is formed. The compound of chlorine and strontium, or *strontane*,³ is a white substance, difficultly fusible, fixed in the fire, a non-conductor of electricity, and of a peculiar bitter taste; when brought in contact with the flame of wax, tallow, oil, or alcohol, it tinges it of a rose colour; and this is a distinctive character of the compounds of strontium; the salts formed from it give this tint to flame, those of baryta give a yellow tint. From direct experiments I ascertained that 50 parts of strontane consisted of about 29 parts of metal and 21 of chlorine; so that it must be regarded as composed of one proportion of strontium, and one of chlorine, 90 and 67.

4. No experiments have as yet been made on the action of strontium, on any of the other elementary substances.

5. None of the compounds of this body have as yet been applied to any of the purposes of the arts, and its combinations are rare in nature.

Calcium

1. *Calcium* may be obtained by the same processes as barium and strontium. Mild calcareous earth, or chalk being used instead of witherite and strontianite; or common well-burnt lime may be employed for making the paste, from which the mercurial amalgam is to be formed by Voltaic electricity.

I first procured calcium about the same time as barium and strontium, but only in very minute quantities, so that little can be said concerning its nature. It appeared brighter and whiter

than these two metals, and burnt, when gently heated, producing dry lime. I have had no opportunity of examining its general physical and chemical qualities.

2. There is only one known combination of calcium and oxygen, which is the important substance, *lime* or *calcia*. The nature of this substance is proved by the phenomena of the combustion of calcium; the metal becomes converted into the earth, with the absorption of oxygen gas. When the amalgam of calcium is thrown into water, hydrogen gas is disengaged, and the water becomes a solution of lime; and from the quantity of hydrogen gas disengaged, compared with the quantity of lime formed in experiments of this kind, M. Berzelius has endeavoured to ascertain the proportion of oxygen in lime. The nature of lime may be also proved by analysis; when potassium in vapour is sent through the earth, ignited to whiteness, the potassium, I have found, becomes potassa, and a dark gray substance of metallic splendour, which is calcium either wholly or partly deprived of oxygen, is found embedded in the potassa, and it effervesces violently, and forms a solution of lime, by the action of water.

Lime is obtained for common purposes, from marble of the whitest kind such as the Parian or Carara marble, by long exposure to a strong heat. It is a white soft substance, of specific gravity 2.3. It requires an intense degree of heat for its fusion, and has not yet been rendered volatile. Its taste is analogous to, but milder than that of baryta and strontia. It is soluble in about 450 parts of water, and seems to be

³ Chloride of strontium.

more soluble in cold than in hot water. It acts upon vegetable colours in a manner similar to the other alkaline earths. When water, in small quantities, is added to it, a considerable heat is produced, a portion of the water combines with the lime, and it becomes a hydrate; but water does not adhere to it with the same degree of energy, as to baria and strontia, for it may be expelled by a strong red heat. From the experiments of M. Berzelius, and those which I have made, it appears that lime consists of about 20 of metal to 7.5 of oxygen, and the number representing calcium is 40, and that representing lime 55; and the *hydrate of lime* must consist of 55 lime and 17 water, which estimation agrees with the experiments of M. Lavoisier and Mr. Dalton.

I have attempted to combine lime with more oxygen, but without success.

3. When lime is heated strongly in contact with chlorine, oxygen is expelled, and chlorine absorbed; and, as happens in all the decompositions of metallic oxides, of which the metals combine with only one proportion of oxygen and chlorine, for every two in volume of chlorine absorbed, a volume of oxygen is expelled. The substance formed by the action of chlorine on lime, as the oxygen of the lime is expelled, must evidently consist of chlorine and calcium. It has been called dry muriate of lime; according to the true view of its composition, it may be called *calcané*.⁴ It is a semi-transparent crystalline substance, fusible at a strong red heat, a non-conductor of electricity, has a very bitter taste, rapidly absorbs water from the atmosphere; and is ex-

tremely soluble in water: by the evaporation of its solution at a low heat, crystals may be obtained, which consist of *calcané*, combined with more than a third their weight of water. From my experiments, it appears that *calcané* consists of 31 chlorine and 19 of calcium, and hence it may be supposed to contain one proportion of the metal, and one of the gas, and the number representing it on this idea is 107; and it is evident, from the experiment on the action of chlorine on lime, that the proportion of oxygen in lime, and of chlorine in *calcané*, must be in the ratio of 15 to 67.

4. As yet no experiments have been made on the combinations of calcium with any of the inflammable, or acidiferous substances, or metals.

5. The compounds of calcium are found abundantly on the surface of the globe, and are of great importance in the economy of nature, and in the processes of art. Lime combined with carbonic acid is an essential part of fertile lands: a number of rocks are constituted by this substance. Gypsum or alabaster, is lime combined with sulphuric acid; and the earth of bones consists of lime united to phosphoric acid. There is no animal or vegetable substance that does not contain larger or smaller quantities of calcareous matter. The uses of lime in mortar are well known. Quicklime, employed as a manure, tends to decompose,⁵ and dissolve inert vegetable matter, and renders it proper for the nourishment of plants; and in this operation the lime is united to carbonic acid, and

⁵ According to the results of my experiment on the action of lime on animal and vegetable substances, it does not decompose, but preserves the majority of them.

⁴ Chloride of calcium.

becomes a permanent part of the soil. In the process of tanning, lime is employed to remove the hair from the skins of animals, and it is used in certain operations of bleaching, dyeing, and other useful arts.

Magnesium

1. *Magnesium*⁶ may be procured from the earth called magnesia, which is the same as the calcined magnesia of druggists, by processes similar to those referred to in the three preceding sections; but a much longer time is required to produce an amalgam of magnesium and quicksilver, by electrical powers, than to produce amalgams of the metals of the other alkaline earths.

I succeeded in decomposing magnesia likewise, in the following manner: I passed potassium in vapour through magnesia, heated to intense whiteness, in a tube of platinum, out of the contact of air; I then introduced a small quantity of mercury, and heated it gently for some time in the tube. An amalgam was obtained, which by distillation, out of the contact of the atmosphere, afforded a dark gray metallic film, which was infusible at the point at which plate glass softened, and which, in the process of distillation of the mercury, rendered the glass black at its point of contact with it. This film burnt when heated strongly, with a red light, and became converted into a white powder, which had the character of magnesia: when a portion of the metal was thrown into water, it sunk to the bottom, and effervesced

⁶ In my first paper on the decomposition of the earths, published in 1808, I called the metal from magnesia, magnium, fearing lest, if called magnesium, it should be confounded with the name formerly applied to manganese. The candid criticisms of some philosophical friends have induced me to apply the termination in the usual manner.

slowly, becoming covered with a white powder; by adding a little muriatic acid to the water, the effervescence was violent; the metal rapidly disappeared, and the solution was found to contain magnesia.

I have made several experiments with the hope of obtaining larger quantities of magnesium, such as might have enabled me to examine its chemical and physical properties; but without success.⁷ It is very difficult to procure a pure amalgam of magnesium by potassium and mercury; the heat must be intense; and at a high temperature, potassium acts with great energy upon platina, so that unless the tube is very solid, it is destroyed in the process, and when the heat is not very great, potassium remains in the tube, which is found afterwards in the amalgam. The potassium may, however, be separated by the action of water; which, even in the amalgam, rapidly converts it into potassa, but which has a much feebler action on magnesium. When the amalgam contains potassium, it likewise usually contains platinum, which is very soluble in the compound of potassium and quicksilver.

2. There is only one known compound of magnesium and oxygen, which is the substance from which the metal is procured, *Magnesia*. That magnesia consists of magnesium and oxygen, is proved both by analysis and synthesis. In the production of magnesium by potassium, the potassium is found converted into potassa, and therefore must have gained oxygen from the magnesia; and in the forma-

⁷ M. Bussy has been successful, by heating together potassium and chloride of magnesium. This metal is not unlike silver in appearance; is malleable, and fusible at a red heat.

tion of magnesia from magnesium, oxygen is absorbed. No experiments have as yet been made to determine the proportions of the elements in magnesia; but from experiments which I have made on the combinations of this substance with acids, assuming that they are single proportions, I am inclined to adopt 43 as the number representing it; and if it be supposed to be constituted by 1 proportion of metal, and 1 of oxygen, the number representing the metal will be 28.

Magnesia appears in its common form, as a white soft powder; its specific gravity is between 2 and 3. It is found in nature in the crystalline form; specimens have been brought from North America, which nearly resemble talc in their external characters. Magnesia has scarcely any taste, no smell; it reddens turmeric. It is infusible; except by the intense heat produced by the combustion of hydrogen gas in oxygen, or that generated by Voltaic electricity. It is scarcely soluble in water, but produces heat when water is mixed with it, and it absorbs a considerable portion of the fluid. When it is procured by the decomposition of a solution in which it is combined with an acid, by means of solution of potassa or soda, it falls down in union with water, as a hydrate; but the water adheres to it with a very feeble attraction only, and is expelled entirely at a red heat. *Hydrate of magnesia* when dried at 212° , appears in coherent semi-transparent masses, very brittle and soft; it contains about $\frac{1}{4}$ of its weight of water.

3. When magnesia is strongly heated in contact with chlorine, chlorine is absorbed, and oxygen expelled, and in the usual proportions as to volume.

Hence it is evident that there exists a combination of magnesium and chlorine; though this body, which may be called *magnesane*,⁶ has never been examined in a separate state. The salt called muriate of magnesia, is a compound of magnesane and water, and when it is acted on by a strong red heat, by far the greatest part of the chlorine unites to the hydrogen of the water, and rises in the form of muriatic acid gas, and the oxygen of the decomposed water combines with the magnesium to form magnesia; some magnesane is, however, found mixed with the magnesia, which affords crystals of muriate of magnesia by the action of water.

4. No experiments have as yet been made on the action of magnesium upon any of the inflammable or metallic substances.

5. The compounds of magnesium occur extensively diffused in nature. Magnesia exists in certain limestones which are found in different parts of Great Britain and Ireland, and which are less fitted for the general purposes of manure than common limestone. Magnesia, in its uncombined state, as appears from the experiments of Mr. Tennant, is injurious to plants, but united to carbonic acid, it seems to form an useful part of the soil: the magnesian limestones are distinguished by their slow solution in acids; and they render weak solutions of nitric acid turbid by their action upon them. Magnesia, and some of its saline combinations are used in medicine; its application in bleaching has been referred to in an early part of this work.

⁶ Chloride of magnesium.

Chem Quiz

What is Element "A"?

by RUTH REICHART and ROGER PERRY

► Can you fill in the names of the elements and compounds represented by A, B, F, P and R? No fair looking on page 55.

1. "B" and "F" are formed in the water solution of a compound of "A." This compound of "A" is called "P."
2. "P" is easily formed by oxidizing "B" which, in turn, is formed by

the action of a metal on "F." "B" is also an oxide of "A."

3. "P" and "R," when dissolved in water in correct proportions will not affect litmus. (The proportion does not have to be known to solve this problem.)
4. "R" is hydrogenated "A."
5. "A" is in air.

Who's Who in the Alkaline Earths

► HUMPHRY DAVY (1778-1829) isolated the four common metals of Group II as described in this month's Classic of Chemistry. Their discovery was an aftermath of the more startling separation of the metals sodium and potassium from substances formerly believed elemental. (The description of that discovery formed part of the Classic in the January 1945 issue of CHEMISTRY.)

In the delightful "Memoirs of the Life of Sir Humphry Davy" (1830), his brother John comments on these researches:

"His labours in electro-chemical science were the most important of all; it was his favourite subject, and almost unremittingly pursued, until brought to a most successful termination. The

first year of the present century was remarkable for the great invention which bears the name of its author—the Voltaic pile or battery,—and for the accidental observation of the decomposition of water by means of it;—or, to express the fact simply, the separation of water under its agency into oxygen and hydrogen. This very remarkable effect of the pile of Volta, which Messrs. Nicholson and Carlisle had the merit of first noticing, impressed powerfully the mind of my brother. He saw in it the connection between galvanism and chemistry;—he expected that it might prove a link between the ponderable and imponderable substances; and even then he had prophetic warnings that it was a passage to a new world of discovery."

For Life and Death. Nitrogen
Is Extracted from Atmosphere

Out of Thin Air

First of a series on basic and war chemicals.

by DR. C. M. A. STINE

Vice President Advisory on Research and Development, E. I. du Pont de Nemours & Co.

► NITROGEN of the air, so far as our body's immediate needs are concerned, is just so much wasted breath. At every inhalation we take in about a half cup of oxygen mixed with a pint of nitrogen. Our blood instantly extracts most of the oxygen to keep us alive, and we breathe out the nitrogen, unused.

Paradoxically, our bodies are about three per cent nitrogen, compounded in the form of protein in our muscles and organs, but that nitrogen we must obtain from food, not directly from the atmosphere.

However, nitrogen from this very same source—the air enveloping our troubled planet—is a key element in almost every charge of gunpowder set off on America's far-flung battle fronts, every bomb dropped on enemy ships and submarines, and every stick of dynamite busily blasting out ores, coal and the foundations for new defense plants.

Nitrogen is, indeed, a vital chemical of war. It is a highly important non-military chemical, as well, being an essential ingredient, for example, of fertilizers. From them it is taken up by food plants, ultimately to become incorporated into the fiber of our bodies. It also is needed in the manufacture of important plastics and lacquers.

Plentiful and free as the air itself,

nitrogen is nevertheless in the "critical" category. Skill, machinery and men are required to pull it out of the air and "fix" or anchor it in such form that it can be united with other chemicals in the final package of explosive. And industry cannot build in a day or a month the tremendous factory additions required to fix nitrogen in the quantities now needed—quantities wholly unprecedented and unprovided for in our peacetime planning. Natural nitrates, such as Chile saltpeter, furnished all of the nitrogen used by the Allies in World War I. Germany, however, obtained her nitrogen from the atmosphere, by a process invented just before the war started. After the war private industries in the United States developed atmospheric nitrogen fixation on a large scale and during the past twelve years or more these industries have supplied all industrial and practically all agricultural demands. Because of the sudden war needs for the chemical, some Chile nitrate is now being imported but because of the hazards of shipping this source is not as dependable during wartime as is the American factory.

First step in the fixation of nitrogen by direct synthesis is the manufacture of ammonia, which consists of one atom of nitrogen and three of hydrogen, NH_3 . The producer starts with only three raw materials, coal, air and

water. Coke, the almost pure carbon left after certain gases and tars have been driven from coal, is poured into six-story-high gas generators and ignited. Air is blown in at the bottom, which raises the coke to a white heat, and the oxygen unites with carbon to form carbon monoxide and carbon dioxide. Trapped with these gases, at the top of the generator, is nitrogen.

The air is then turned off and steam is turned on. The white hot carbon (coke) splits the molecule of steam, which is H_2O , combines with the oxygen to form carbon monoxide and sets the hydrogen free. The alternate blowing of air and steam through the coke goes on continuously, twenty-four hours a day. Fresh coke, of course, is added at the top of the generator.

These four gases—nitrogen, hydrogen, carbon monoxide and carbon dioxide—are the starting materials for more than a hundred useful chemicals. We are here interested only in the first two gases, nitrogen and hydrogen. But to obtain them in pure form the others must be removed from the mixture. This is done in a rapid-fire succession of chemical and physical punishments including pressures up to that in the breech of a large cannon at the moment of firing. The mixture is "scrubbed" with water, which carries off the carbon dioxide in solution, leaving the less soluble nitrogen and hydrogen behind.

Finally, the hydrogen and nitrogen atoms find themselves alone, and with a metal catalyst acting as the chemical parson, they are wedded, and you have ammonia.

For the making of explosives the ammonia is converted into nitric acid.

This is done by burning the ammonia in air at a very high temperature and in the presence of another chemical parson. The wedding this time is between the nitrogen and its old friend, the oxygen of the air, from which it had been so forcibly separated back in the ammonia factory. As the oxide of nitrogen combines with water the nitric acid is formed. This, under most carefully controlled conditions, is mixed with sulfuric acid to form a suitable mixed acid, which acts upon toluene to form TNT, on glycerin to form nitroglycerin, and on cellulose to form gunpowder and smokeless powder. These reactions, of course, have to be carried out in highly specialized apparatus and under the most skillful and experienced chemical control.

Chief function of the nitrogen is to hold oxygen, combined with it as a nitro group. The molecule of explosive thus contains not only the fuel to be burned—toluene, glycerin or cellulose—but the oxygen to burn it. All are combined in intimate contact, ready to rearrange themselves at the moment of combustion to form gases.

The gases, of course, take up many times as much room as the solid explosive from which they are derived. Furthermore, the temperature of the exploding mass is so extremely high—about 6300 degrees F.—that the hot gases occupy many times the volume that they would occupy at ordinary temperatures. The result is that this tremendous volume of hot gases elbows everything out of its way to get increased room for expansion and this produces the destructive effect of the explosion.

Future of Powder Metallurgy

► SCIENTIFIC and technologic activity in powder metallurgy is great at the present time and we can look forward to an ever-expanding horizon with newer and better products resulting from the application of this interesting process. Dr. Zay Jeffries of the General Electric Company declared at a meeting at the Stevens Institute of Technology, where he was the first recipient of the annual powder metallurgy medal of the Institute.

Powder metallurgy, he said, offers a means of utilizing various properties of metals to their best advantage. It is a means of mixing metals which do not readily mix in a liquid state, and a means of mixing metals that melt at very high temperatures. In powder metallurgy, a metal, or a mixture of metals, in the form of powder is pressed into briquets and consolidated into a firm body by heat-treatment, or what is known as sintering. Sintering joins the particles together by making millions of minute welds.

A good example of the application of powder metallurgy is the cemented carbides for cutting tools, wire drawing and other dies. This material, which consists essentially of hard par-

ticles of tungsten carbide sintered with a small quantity of metallic cobalt, utilizes the tremendous hardness of the carbide for cutting and the wear-resistant properties and it utilizes the toughness of cobalt to keep the hard, brittle tungsten carbide in one piece in service. No other method is known at the present time to make this cemented carbide or products which even approach them in effectiveness.

Powder metallurgy is employed in the production of tungsten rods and filaments for the lamp, radio, electrical contact and other industries.

"In this case," Dr. Jeffries said, "the melting point of tungsten is so high that no satisfactory method has ever been found of melting and casting it into ingots. The tungsten powder is produced by reducing tungsten oxide with hydrogen. The powder is pressed into briquets and heated by the passage of electric current to a temperature near 3200 degrees Centigrade."

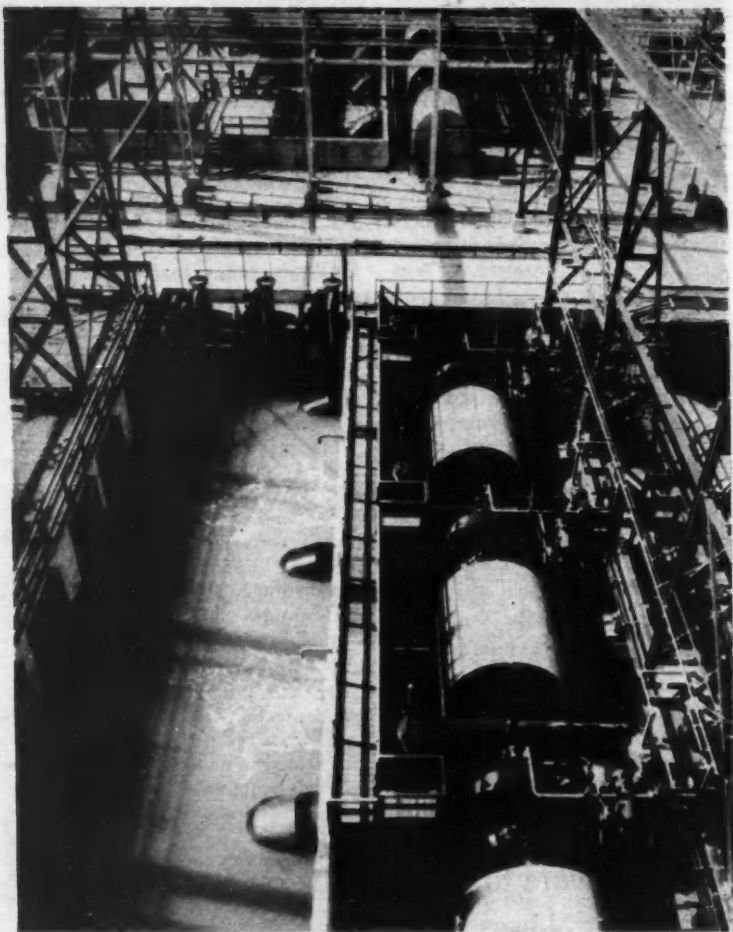
Dr. Jeffries discussed the history of powder metallurgy, an art known and used for many years, but which has had extended applications only in the past few years since better techniques have been developed.

Answers to Chem Quiz on Page 52

► "A" = N; "B" = NO; "F" = HNO_3 ; "P" = NO_2 ; "R" = NH_3 .

Ruth Reichart was one of the Washington Trip Winners in the Fourth Annual Science Talent Search, and attended the Science Talent Institute

in March of this year. She and Roger Perry are members of the S.C.A. Science Club of the New Rochelle High School, sponsored by Dr. Carleton S. Spear. They made up the quiz "just for fun."



➤ **NEW BROMINE EXTRACTION UNIT**—Sea water pumps are shown pumping water from which there will be extracted the bromine. Ethylene is produced in another part of the plant and it reacts with the bromine to form the ethylene dibromide.

New Plant Increases Supply of Sea Water Extract for Aviation Gas

Bromine for 100-Octane Gas

► MORE ANTI-KNOCK gasoline is promised for the near future so that our bombers can leave extra souvenirs in Japan's homeland. An ethylene dibromide plant, recently built next to a sister plant in Freeport, Texas, will help make this possible.

All 100-octane gasoline includes an extract from sea water. Some ethylene dibromide, the ingredients made from sea water to be added to tetraethyl lead to make Ethyl fluid, is used in all aviation gasoline so the engines won't knock. The fluid controls the burning of the mixture of gas and air so the engine can get full benefit from combustion.

Parts of the new plant were completed early enough in 1944 to result in a 29 per cent increase in production for last year as compared with the preceding year. In full operation the plant, one of three in this country, is expected to produce 32,000,000 pounds of ethylene dibromide a year. This will mean an increase of nearly 40 per cent over production at former plants.

Although built by the Ethyl-Dow Chemical Company to fill the need for more aviation gasoline to hasten the end of the war, the ethylene dibromide produced by the plant is expected to make our postwar driving easier and smoother. Company officials predict that most gasoline after the war will be treated with Ethyl fluid.

First the sea water is treated with hydrochloric acid to get hydrobromic

acid. This in turn is reacted with ethylene to produce ethylene dibromide. To every gallon of refinery-base aviation gasoline 4.66 cubic centimeters of tetraethyl lead and the proportionate amount of Ethyl fluid are added to make 100-octane gasoline.

The first sea-water bromine plant was operated only about six to eight hours in May, 1925, then was shut down forever. Costing around \$360,000, it still was considered a success—it proved that bromine could be produced from sea water in usable form. Up to that time only small amounts of bromine were being used, chiefly in headache powders and light-sensitive bromide crystals upon which photography is based.

The first plant was amphibious, and sailed under the name of S.S. Ethyl. A lake-type cargo ship, it was converted into a floating chemical factory. Pumps discharged water in the wrong places, she floated too high, and instead of going any definite place, she just meandered along on an erratic course that crossed and re-crossed itself out in the Gulf Stream.

The cargo hatches on deck had been replaced by large skylights for light and ventilation. Below was a plumber's nightmare—a confusion of heavy tanks, pumps, drums, blowers and massive piping.

The ship didn't actually get pure bromine out of the Gulf Stream, but a bromine compound of aniline. Its suc-

water
another
mide.

HISTORY

cess led to the development of the short-cut process used today in extracting nearly pure bromine from sea water.

In finding a suitable location for such a plant, several things must be considered. There must be an unlimited supply of clean ocean water at some point where the bromine content is relatively high and the water warm enough for this chemical to be extracted feasibly.

There must also be some way of dis-

charging the waste water so it will not dilute the incoming water. This is important since there is only about a half pound of bromine in every thousand gallons of salt water. At the Freeport plant, bordering on the Gulf of Mexico, the waste water at the end of the process is poured into an abandoned channel which discharges it back into the gulf about seven miles from the plant.

Postwar Glass from Aluminum and Phosphorus

► VOLUME PRODUCTION of aluminum metaphosphate planned for the post-war era will bring into commercial availability a useful glass.

From aluminum metaphosphate can be manufactured glass which transmits a substantially greater amount of ultraviolet light such as aids the formation of vitamin D.

Aluminum metaphosphate's use in the making of glass represents a radical departure from such bases as lead, well-known to the ancients, and from the more recent combination of sand, soda ash and lime. Aluminum metaphosphate is derived by Monsanto Chemical Company largely from aluminum and elemental phosphorus.

Postwar fluorescent lights may utilize phosphate glass due to its ultraviolet permeability, and it also may be found useful in windowpanes of hospitals and solariums.

Because they show less tendency to yield a haze, phosphate glasses are considered likely to solve some optical problems associated with astronomy, photography and related fields.

Phosphate glasses show improved

weather resistance, improved color control, improved melting and working characteristics and improved resistance to some acids. Used in insulators, they reduce loss of electrical current as compared with other glass insulators.

A companion metaphosphate has properties that suggest its ultimate use as a heat insulator. Its volume increases 500-fold under high temperatures. Another metaphosphate, also ready for volume production, is used in ceramics.

Monsanto's Phosphate Division has produced a new white paint pigment, called tetra lead pyrophosphate, which in light-reflecting tests is superior to the usual titanium pigment. Another product is ferric orthophosphate, which can be used in flour and cereals to give them more than twice their normal amounts of iron.

Each of these products is based on elemental phosphorus, which burns fiercely on exposure to air, and is widely used in incendiary bombs and mortar shells. Monsanto produces elemental phosphorus in a plant near Columbia, Tenn. Its current output is about ten times that of the entire nation during World War I.

Congress Considers Uses of Light Metals in Industry

Future of Aluminum and Magnesium

► ALUMINUM and magnesium had their day in Congress at hearings before the Senate Small Business Committee, which considered, among other matters, the future of these light metals and what to do about the government's investment of over a billion dollars in plants for their production.

Producers of these light metals, and users extending from aircraft manufacturers to kitchen utensil fabricators, were heard. Representatives of heavy industries, such as builders of automobiles, railroad cars, and farm machinery, presented opinions of their possible future uses in their industries by invitation of the committee.

Aluminum naval destroyers able to travel at 60 knots, as well as magnesium truck and trailer bodies, were predicted by Henry A. Kaiser, the shipbuilder, who stated that plans for the destroyer are already complete and that magnesium-bodied trucks are now on the road. These bodies cost twice as much as bodies of steel, but, on those now in use, by one of his companies, can haul four tons more pay-load. He suggested that the government plants be leased or sold to private companies.

The supply of magnesium in the United States is limitless, declared Dr. Willard H. Dow, head of the Dow Chemical Company. The only limit is the amount of electricity available for its production. Magnesium as a metal, he said, has been known for more than a century, but only for about 25 years

has it developed as a structural material. Then it was found that if other metals are mixed with magnesium in various proportions, the alloy gives magnesium a new character and it becomes a tough, easily machined, corrosion-resisting metal in every way suitable for construction in which light weight matters. He suggested many possible uses, including aircraft, railroad equipment, automobile and truck bodies, furniture, shipping containers, machinery, home construction, and in the oil industry, particularly to protect pipe lines from electrical deterioration.

Aluminum production by the Reynolds Metals Company, which up until 1941 was a fabricator, not a producer of this metal, was discussed by R. S. Reynolds, president of the company. The possibilities in the future for aluminum are enormous, he said, but so are the problems. "If the government adopts sound policies for the disposal of its own plants and for their subsequent operation, real dividends in jobs and consumer goods will be produced."

On the question of the policy to be adopted in the disposition of government-owned aluminum plants, I. W. Wilson, of the Aluminum Company of America, declared that laying down a hard-and-fast rule at this time would be an unwise step for Congress to take. No one can tell the length of time that will be required to develop postwar aluminum markets.

"A year after peace has been made,"

he said, "Congress and the industry will be better able to gauge the future; two years after peace they may be still better able to judge the future."

He referred to the possibilities of the use of vast quantities of light metals in the construction of naval vessels, passenger and cargo ships. He submitted a list of 2,000 items in which aluminum was or could be used to advantage.

Adoption of a national air power policy for the development of postwar military and civilian aviation is necessary to assure realization of present promising opportunities for the light metals in the aircraft field, Eugene E. Wilson, president of the Aeronautical Chamber of Commerce, told the committee.

"The future of air transport, civil and military, is more dependent upon light metals than that of any other industry," he said. "The extent of the postwar demand for light metals from the aircraft manufacturers cannot be foretold because the volume of postwar production of military and commercial planes largely depends upon public policy, which Congress must determine."

There will be little change in the relative quantities of steel, iron, aluminum and magnesium in civilian postwar cars as compared with the ratios established in prewar production, according to J. S. Laird of the Ford Motor Company. Magnesium is unsuitable for more than a few of the many items which make up an automobile, and its use is ruled out for engine parts which are highly stressed, or must be wear-resistant, as well as for water-cooled cylinder blocks and heads, he stated. Aluminum castings have been used successfully, he continued, in cylinder blocks, cylinder heads, oil pans, pistons, timing gears and housing.

"Wheel type and tracklaying tractors for farm or industrial uses depend largely upon their weight to develop satisfactory draw-bar power," declared A. W. Scarratt of the International Harvester Company at one of the hearings. Tillage and harvesting machines, such as plows, harrows and mowers, also require weight, so that no appreciable use of the light metals may be expected in these machines, he said, and their use will be confined to relatively few parts.

High Vacuum Research Fellowship

➤ A GRADUATE FELLOWSHIP in high vacuum research has just been established at the Massachusetts Institute of Technology with funds donated by the National Research Corporation of Boston. An initial grant of \$2,500 has been

made. It is expected that the award will foster interest in new processes performed under high vacuum in the fields of chemistry, physics, metallurgy, and chemical and mechanical engineering.

Although many substitutes for gasoline to power motor cars have been found, no satisfactory substitute for petroleum lubricating oil has been located or developed.

Science Can Create New Industries

➤ SCIENCE AND INVENTION offer the means of creating new industries after the war and preventing unemployment, and engineers must be ready and willing to undertake the responsibility. This is the conviction of Dr. Ernst F. W. Alexanderson, of the General Electric Company, expressed at a dinner held in his honor by the American Institute of Electrical Engineers and at which he was awarded the coveted Edison medal, given annually by the Institute for achievements in the electrical field.

"When viewed through the blue spectacles of the economist, the world looks gloomy," he said. "If, on the other hand, we put on the rosy spectacles of the inventor, the world looks different. The creative talent is here. We have proved it through two wars. The engineers are eager to do their part in creating new industries."

While William James, the noted economist, was racking his brains to find the moral equivalent of war to increase employment, Dr. Alexanderson-declared, "Edison had a different approach. He did something about it and created the electrical industry. Then Marconi stepped in and started the radio business. Is not this what the world needs—engineers who can create new industries?"

"What right have we to say at this time that science and invention have been exhausted and that we are no longer able to create new industries?" he continued. "If the only work that

we can see ahead of us is to do more efficiently and in greater volume the things we know how to do now, then we must also accept the sad but logical conclusions of the economists. A thousand years from now maybe we will have exhausted science and invention and our civilization will be superseded by another, but the engineering age is only a couple of hundred years old and we stand at the apex of technical evolution. Scientific progress during the war has given us a wealth of new ideas to work with."

Dr. Alexanderson presented some of the electrical applications probable in future developments. These included heating and cooling homes by electricity, driving ships by electric motors fed from coal burning gas turbines, using now undeveloped water power to electrify railroads, and using electronics in new ways in communication and industry.

Invention, he said, must be given a broader meaning than the usual one. It should mean "resourcefulness in dealing with new situations and eagerness to put new ideas to practical work."

Dr. Alexanderson, the Swedish-born consulting engineer of the General Electric Company, developed the high-frequency alternator which made the first radio broadcast possible, and many other electrical appliances widely used in radio, radar, television, and other important electrical achievements.

Poison powders ground very fine are usually more effective as insecticides than the same powders in larger particles.

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